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ENGINEERING AND EQUIPMENT

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AERONAUTICAL AND SPACE

UDC 534.1:539.3

DETERMINATION OF STRESSES IN ELASTIC AVIATION SURFACES DURING MOVEMENT IN UNSTEADY STREAM

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 3 Oct 83) pp 26-29

VAKHITOV, M. B., SAFONOV, A. S. and KUZNETSOV, I. A.

[Abstract] A numerical method based on a discrete-continual model is developed for determining the stress-strain state of thin-walled aviation bearing members (such as wings and empennage) subjected to time-varying loading in an unsteady flow. The model employs Yu. G. Odinokov's theory, in which there are no restrictions on the deplanation of the member, but the kinematic hypothesis that the cross sections cannot be deformed when subjected to loading is employed. The algorithm has been implemented in FORTRAN-IV to run on a YeS computer. The dynamic responses of a wing to a discrete gust are calculated as an example. References 5 Russian.

[6900-100/12947]

UDC 539.3:529.7.02

STABILITY OF SHELL MEMBERS OF ENGINE INSTALLATIONS WITH VARIABLE RIGIDITY PARAMETERS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 22 Feb 83) pp 30-34

GIRIN, A. M.

[Abstract] A method is proposed for investigating the stability of cylindrical orthotropic shells in which the thickness, the flexural rigidity in the direction of the generator, the circumferential flexural rigidity and the torsional rigidity vary along the generator due to design or technological factors. Allowance is also made for irregularity of distributed axisymmetrical external loads. Differential and integral stability equations are derived. Analytical relationships are obtained for cantilevered shells. References 2 Russian.

[6900-100/12947]

UDC 681.515

OPTIMUM PARAMETRIC CONTROL OF OBJECTS WITH DELAYING ARGUMENT

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 14 Feb 83) pp 34-38

DEGTYAREV, G. L.

[Abstract] The problem of determining the control parameters in systems with delay is investigated for incomplete and imprecise state measurement. Vector equations and initial conditions describing the controlled process and the measurement process are presented. A functional characterizing the current accuracy of the controlled movement is employed as the optimality criterion. A closed system of equations is obtained for determining the parameters that provide maximum current stabilization accuracy. References 5 Russian.
[6900-100/12947]

UDC 539.4

QUASISTATIC ANALYSIS OF COMPOSITE BEARING SURFACES IN STREAM OF INCOMPRESSIBLE GAS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 2 Jul 82) pp 50-55

PAVLOV, V. A., GAYNUTDINOV, V. G., MIKHAYLOV, S. A. and PORTNOY, V. A.

[Abstract] A geometrically nonlinear method is proposed for analyzing composite bearing surfaces such as a stabilizer-rudder system that is more accurate than the traditional approach. The rudder and stabilizer surfaces are represented as two thin-walled rods coupled together and subjected to a running aerodynamic load. The aerodynamic characteristics during each loading step are found by S. M. Belotserkovskiy's method, in which the schematized bearing surface and its wake are replaced by a three-dimensional eddy surface with the appropriate shape. The wing and aileron of an actual aircraft are analyzed as an example. References 9 Russian.
[6900-100/12947]

UDC 539.3:621.391

OPTIMUM PROBABLISTIC DESIGN OF FLIGHT VEHICLE MEMBERS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 27 Mar 83) pp 59-63

PERLIK, V. I., SAVCHUK, V. P. and KHARITONOV, G. G.

[Abstract] The general problem of optimum probabilistic design of flight vehicle members is formulated in mathematical programming terms. Methods for solving the problem are investigated, with an attempt to combine design tasks and to ensure reliability by using reliability models which are tied in adequately to the methods used to analyze the members. Employed as an example is an optimum design problem in which weight and reliability requirements must both be satisfied. In a comparison with the traditional determinate method, the proposed probabilistic optimization method yielded a gain in the weight parameter. References 6 Russian.

[6900-100/12947]

UDC 681. 3.5.01

TOWARD THE PROBLEM OF DETERMINING AN OPTIMAL FLIGHT CONTROL PRINCIPLE FOR AIRCRAFT

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 8 Feb 83) pp 63-68

ROMANENKO, L. G.

[Abstract] Characteristic polynomials with coefficient values based on technical considerations are determined. The assignments of the coefficients imposes a simultaneous restriction on the sum and product of the roots of the characteristic equation, making it possible to design a constructive regulator and to minimize the integral quadratic estimates. Formulas are derived for computing the sought coefficients of the polynomial for sixth-, seventh- and eighth- order systems. The problem of controlling the center of mass of an aircraft is examined, assuming that control is exerted by applying lateral forces created by rolling to the aircraft. The sought control demonstrates that all of the autopilot transfer numbers can easily be implemented in practice. References 6 Russian.

[6900-100/12947]

UDC 533.6.011

CALCULATION OF AERODYNAMIC CHARACTERISTICS OF WINGS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 31 Mar 83) pp 72-77

SIDOROV, O. P.

[Abstract] This study investigates the flow about a long wing with geometric and aerodynamic twisting in an ideal incompressible gas. The circulation along the wing span is calculated, and the lift, inductive resistance and downwash angle of the flow are determined. Twisting is found to result in inductive resistance even in the absence of lift. References 4 Russian.
[6900-100/12947]

UDC 581.511.4.037

INVESTIGATION OF STABILITY OF THREE-DIMENSIONAL MOVEMENTS OF FLIGHT VEHICLES

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 10 Oct 83) pp 77-81

SIRAZETDINOV, T. K. and AMINOV, A. B.

[Abstract] An approach based on Lyapunov's second method is proposed for investigating the stability of spatial movements of flight vehicles with simultaneous allowance for aerodynamic, inertial, kinematic and equipment interrelationships, and for nonlinear relationships between existing forces and moments. The case of perturbed flight vehicle movements described by a normal system of ordinary differential equations with polynomial right part is examined. An equivalent problem is stated for defining the set of flight vehicle characteristics that provide asymptotic stability of unperturbed movement. The problem is solved in accordance with the Barbashin-Krasovskiy theorem of asymptotic stability, by representing the polynomials in n variables as elements of a linear (vector) space. An example is used to demonstrate the method. References 7 Russian.
[6900-100/12947]

UDC 629.735.33

OPTIMIZATION OF PARAMETERS TRANSPORT AIRCRAFT WITH LIFT-FUSELAGE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 23 Nov 83) pp 87-89

BADYAGIN, A. A. and CHEPURNYKH, I. V.

[Abstract] The problem of lift-fuselage aircraft parameters is solved approximately for loads ranging from 12.5 to 200 tons. The load per square meter of wing during take-off, the relative centerplane area, the extension of the cantilevers, the number of engines and the flight altitude were optimized. The problem was solved by computer by the random- and adaptive-search methods, as well as Powell's method. It was found that the rational number of engines is determined mainly by the load for all flight lengths and aborted take-off lengths. The strongest optimum is demonstrated by the flight altitude, the extension and relative area of the centerplane and the load per square meter of wing during take-off. References 4 Russian.
[6900-100/12947]

UDC 629.7.02:539.4

STRENGTH ANALYSIS OF AVIATION MEMBERS BY MIXED SUPERELEMENT METHOD

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 12 Sep 83) pp 89-91

BURMAN, Z. I. and DESYATNIK, G. A.

[Abstract] This study employs a version of the superelement analytical method for aviation construction members in which individual submembers are designed in accordance with different models from the finite element method, after which the superelements thus calculated are merged into a unified whole. This approach makes it possible to calculate irregular members effectively and to select the more suitable model for each section. An algorithm is presented for analyzing non-fixed construction members such as helicopter fuselages. The algorithm has been implemented as a package of programs which is part of the SUMR/K (superelement method for designing aviation construction members) software complex. The tail section of a helicopter is analyzed as an example. References 4 Russian.
[6900-100/12947]

UDC 624.074

TOWARD A METHOD OF EXPERIMENTAL INVESTIGATION OF PERFORATED THREE-LAYERS SPHERICAL SHELLS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 1 Feb 83) pp 93-95

KOTELNIKOV, V. U. and TARASENKO, V. G.

[Abstract] This study examines the experimental investigation of deformation of medium-thickness perforated three-layer shells, with variable-thickness bearing layers, subjected to external pressure. Meridional and annular deformations of the internal bearing layer is investigated for thicknesses ranging from 0 to 100 mm. The proposed method reduces the influence of spread in the mechanical properties of a member on the accuracy with which the strain state of a construction member weakened by perforations is investigated. The experimental data obtained makes it possible to check the theoretical models for calculating real shell constructions. References 3 Russian.

[6900-100/12947]

UDC 65-522.6(088.86)

STATIC CHARACTERISTICS OF HYDRAULIC PROPORTIONAL PLANE FLUIDIC AMPLIFIER

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 84 (manuscript received 5 Dec 83) pp 99-101

FRANK, E. G. and PUSHKARENKO, A. B.

[Abstract] A method is proposed for analyzing the static characteristics of proportional plane fluidic amplifiers operating under conditions of turbulent fluid flow. The flow rate of proportional fluidic amplifiers is analyzed as a function of the control pressure for various loads calculated by the equations derived in the study and obtained experimentally. The calculated and experimental results agree to within 7.5%. References 3 Russian.

[6900-100/12947]

SOLUTION OF INVERSE PROBLEM OF DETERMINING THERMODYNAMIC PROPERTIES OF
WORKING BODY OF GAS TURBINE ENGINES

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in
Russian No 2, Apr-Jun 84 (manuscript received 24 Jan 84) pp 107-108

PROKOFEV, A. N.

[Abstract] An algorithm is proposed for solving the inverse problem of computing the inverse thermodynamic functions $T(i^*, q)$, $T(s^*, q)$ by selecting a 'good' initial approximation for the temperature without iteration. Explicit formulas are derived for calculating initial temperatures approximations which satisfy the stated requirement for arbitrary values of the thermodynamic functions i^*, s^* and relative fuel consumption. The algorithm makes it possible to compute the temperature 5 - 10 times faster than by A. P. Tunakov's method.

[6900-100/12947]

SURFACE TRANSPORTATION

UDC 621.892.001.4

QUALIFICATION TESTS OF LUBRICATING OILS FOR DIESEL LOCOMOTIVES

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 22-23

REZNIKOV, V. D., candidate of technical sciences, SHIPULINA, E. M., candidate of technical sciences, and YURCHENKO, P. F., engineer [deceased]

[Abstract] Qualification tests were performed on domestic and foreign lubricating oils in ChN 26/26 diesel locomotives, for the purpose of guidance in improving the maintenance of lubricant in 2TE116 diesel locomotives without structural design modification. Four grades of lubricating oil (M-14G₂, SK, MD, EL) were tested for 10 performance indicators: kinematic viscosity at 100°C, viscosity index, KOH-alkalinity number, sulfate ash content, pour point, open-crucible flash point, high-temperature oxidation resistance, corrosion resistance on lead plates, stability during inductive sedimentation phase, detergence potential. They were furthermore tested for corrosion, wear, and detergence of diesel shaft and bearings. All grades were found to be almost equally resistant to high-temperature oxidation, within the 48.4-58% range, except the imported MD oil with a much higher resistance and only 32% increase of kinematic viscosity at 250°C. All grades were found to be corrosion-resistant within specifications, foreign grades not having been tested on the assumption that they meet even more stringent requirements. Accordingly, all grades fall into the G₂ class or equivalent API CC class. The detergent power of M-14G₂ oil was significantly improved by addition of A-9250 ashless dispersant. Tables 3; references 2: 1 Russian, 1 Western. [197-2415/12947]

UDC 621.374

ASYMPTOTIC STABILITY OF SYSTEMS WITH PULSE WIDTH MODULATION

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 19 Mar 84) pp 18-22

LYANOVA, N. I., Leningrad

[Abstract] Necessary and sufficient conditions for asymptotic stability on-the-whole of first-order systems with pulse width modulation are established

on the basis of three theorems. The structure of such a system is reduced to its essential three components: a clock-pulse generator forming a sequence of o-pulses with constant period T , a pulse modulator forming a sequence of pulses with unity amplitude, and a continuous-duty device acting as demodulator. The beginning of every modulator output pulse is rigidly tied to the o-pulse sequence of its duration is determined by some error function at the instant of time $t = nT$. The first theorem pertains to the characteristics of generated pulses, depending on the characteristic polynomial and the error function. The second theorem pertains to the null-state equilibrium of the system. The third theorem pertains to mutually unique correspondence between the control signal and the duration of generated pulses. This method of stability analysis can be extended to systems with pulse amplitude or pulse frequency modulation. Figures 1; references: 5 Russian.
 [127-2415/12947]

UDC 62.50

VECTOR OPTIMIZATION OF BRAKING OF AIRCRAFT IN AIR

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA MEKHANIKA in Russian No 1, Jan-Feb 85 (manuscript received 23 Mar 83) pp 67-70

LOKSHIN, B. Ya., PRIVALOV, V. A. and RYZHOVA, V. Ye.

[Abstract] Braking of an aircraft by both natural aerodynamic drag and an additional control action opposing the velocity vector is analyzed for optimization purposes, assuming that the center of mass moves in a vertical plane in a uniform gravitational field with the opposing aerodynamic drag force proportional to its velocity squared. The equations of motion in dimensionless variables are $\frac{dv}{dt} = -\cos\theta - v^2 - n(t)$ and $\frac{d\theta}{dt} = -\frac{\sin\theta}{v}$, $v(0) = v_0$, $\theta(0) = \theta_0$, $0 < \theta_0 \leq \frac{\pi}{2}$ (v -velocity of the center of mass, θ -counterclockwise declination angle of the aircraft trajectory from the vertical, t - dimensionless time, n - control force which brings the aircraft to full stop: $n(t)$ - incremental-continuous function of time with bounded $0 \leq n(t) \leq n^*$, $n^* > 1$). The problem of optimizing the braking process is formulated as a problem of optimizing three functionals: braking altitude $I_1 = \int_0^T v \cos\theta dt$, braking time $I_2 = T$, total impulse of control force $I_3 = \int_0^T n(t) dt$ under the constraint that $v(T) = 0$ (T - time to full stop). This problem is solved by construction of the corresponding Pareto optimum set with the aid of two related auxiliary unicriterial partial problems: minimization of functional I_1 and minimization of functional I_2 , each on the set of admissible controls $n(t)$ which will make functional $I_3 = \text{const}$. The first minimization problem is treated as a Mayer problem and is solved in accordance with the Pontryagin maximum principle. The second minimization problem is treated and solved as speed-of-response problem. Their solution reveals that, for a given magnitude of the constant impulse $I_3 = c$, the same control will minimize both braking altitude and braking time. Accordingly, the Pareto optimum set in the space of three functionals contains no two-dimensional manifolds and lies entirely on some one curve. References 3: 2 Russian, 1 Western (in Russian translation).
 [164-2415/12947]

DYNAMIC EDGE EFFECTS DURING AEROELASTIC VIBRATIONS OF PLATES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 84 (manuscript received 18 Jun 81) pp 175-180

ZHINZHER, N. I., Moscow

[Abstract] Shape stability of a rectangular elastic and isotropic plate edgewise facing a supersonic gas stream is analyzed, its front edge and back edge being supported on hinges and the two lateral edges being rigidly clamped. Assuming that the pressure on the bottom surface is equal to that of the quiescent gas stream, the aerodynamic excess pressure on the top surface is stipulated in accordance with the plunger theory. The equation of elementary motion about the equilibrium position is put in complex notation, whereupon the real part of the solution for the deflection as function of Cartesian space coordinates and time is sought as the inner solution. The corresponding boundary-value problem reduces to a nonself-adjoint one-dimensional differential equation whose eigen-values are determined from particular linearly-independent solutions, roots of the characteristic equation in flutter frequency and flutter velocity with two yet unknown wave numbers. The latter equation is solved by the asymptotic method in an algebraic form which reveals the dynamic edge effects as well as their nondegeneracy and decay. The critical flutter velocities are calculated by reference to an infinitely long plate and the dispersion equation. The latter yields those roots of the characteristic equation as a function of flutter frequency with branching points which fall on the real frequency axis at the critical velocities and lie in the lower half-plane when the plate is stable. Solving this stability problem by the asymptotic method has thus become equivalent to finding the zero minima of a target function of six variables. This was done numerically by the Nelder-Mead method. The author thanks A. G. Voronov for assistance in calculations. Figures 3; references 13: 7 Russian, 6 Western.

[163-2415/12947]

SOME PROBLEMS OF WEIGHT REDUCTION FOR STRUCTURES IN STATE OF FORCED HARMONIC VIBRATIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 84 (manuscript received 9 Apr 84) pp 147-154

IVANOVA, S. Yu., Moscow

[Abstract] The problem of weight minimization by optimization of the thickness profile is solved for thin elastic structures subject to steady-state forced harmonic vibrations. Minimization of the weight functional is achieved by relating the thickness variation to variation of the Valentine auxiliary

control function. The algorithm of successive optimizations by the method of steepest descent, first for a static load as zeroth approximation and then with correction for a harmonically varying load as first approximation, is applied to the typical self-adjoint problem of minimizing the volume of a thin elastic beam or plate under the constraint of integral stiffness limiting the amplitude of work done by applied forces. The structure is assumed to be symmetric with respect to its center and the load to be acting at that point. Dimensionless calculation have been made for hinge-supported plates and rigidly clamped plates subject to a static load and to forced vibrations at respectively 10 and 15 times their natural frequencies. The results indicate a weight advantage of 20.3% in the first case and 36.6% in the second case, relative to a plate of uniform thickness. Figures 6; references 8: 2 Russian, 6 Western.

[163-2415/12947]

UDC 531.53

LOCATION OF STOPS IN PENDULUM-TYPE INSTRUMENTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 84 (manuscript received 21 Sep 83) pp 11-18

VALKO, A. D. and GRUDEV, I. D., Moscow

[Abstract] An instrument is considered with a pendulum as sensing element, its pivot being a jumper of symmetrically variable cross section, smallest at the center, between two collinear elastic hinges acting as stops. The performance of such a sensing element under a dynamic load acting parallel to the sensitivity axis is analyzed for the purpose of properly locating the stops. Calculations are based on the corresponding system of equations of pendulum motion and stop deflection. One critical time parameter is the length of time from impact by the pendulum to maximum stressing of a stop, which depends on the dynamic properties and the initial velocity of the pendulum as well as on the dimensions of a stop and the strength of its material. Another critical time parameter is the length of time in which the pendulum will reach a stop after being swung, this time also depending on the dynamic properties and the initial velocity of the pendulum, and furthermore on the dimensions and the location of that stop. On the basis of these relations, the sensing element can be designed for maximum reliability by ensuring zero residual strains in the stops. Their proper location can be determined from the solution to the equations of motion, energy, and momentum after impact for the appropriate initial conditions. Figures 3; references: 1 Russian.

[163-2415/12947]

MARINE AND SHIPBUILDING

UDC 621.039.526

OPTIMAL PARAMETERS OF ATOMIC GAS-TURBINE PLANTS WITH RADIATOR-AND-AIR COOLING TOWER

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 84 (manuscript received 11 Mar 83) pp 104-106

LARIN, Ye. A., candidate of technical sciences, docent, and DEREVYAGIN, A. M., engineer, "Order of Labor's Red Banner" Saratov Polytechnic Institute

[Abstract] A mathematical optimization study was made for an atomic gas-turbine plant with fast reactor. As a typical reactor was selected one operating with spherical fuel elements, $(U+Pu)_2$ fuel in the core (plutonium charge 1.15 t/GW) and UO_2 fuel in the breeder (breeding ratio 1.65), average burnup rate of 100 GW.days/t, and using helium under a pressure of 16.0 MPa (inlet temperature 480°C, outlet temperature 800°C) with a 0.64 MPa pressure drop across the reactor. Calculations have yielded the optimum expansion ratio in the turbine (2.27), optimum dimensions of regenerator and cooler tubings, optimum parameters of the cooling tower with radiator columns and air circulation in addition to water, and an overall plant efficiency of 39.3% at thermal and electric power levels of 4000 MW and 1572 MW respectively. Article was presented by Department of Heat Power Engineering. Tables 2; references 4: 3 Russian, 1 Western.

[119-2415/12947]

COMPUTER-AIDED CALCULATION OF FUEL LOSSES ON STARTUP OF 300 MW POWER UNITS IN KONAKOVO GRES

Moscow ENERGETIK in Russian No 9, Sep 84 pp 2-4

IVANOV, N. V., candidate of technical sciences, VASILYEV, V. G., engineer, MALYSHEVA, L. I., engineer, and TIMOFEEV, A. V., engineer, All-Union Institute of Heat Engineering imeni Dzerzhinskiy and Konakovo GRES

[Abstract] The technical and economic indicators of the Konakovo GRES, which is integrated into the Central Unified Power Grid, depend largely on the fuel expenditure for startup of its 300 MW power units. For the purpose of evaluating the fuel flow and controlling the startup performance, since the

startup fuel is not available for generation and distribution of energy, a computer program has been developed which covers the entire starting period. Calculations are based on the unimodular scheme of parallel starting operations in both boiler shells, according to the conventional GRES technology. The startup period is subdivided into four successive stages: 1) preparation of boiler and turbine; 2) firing of boiler; 3) loading from initial level till transfer from separate electrically driven boiler feed pump to turbine-driven boiler feed pump; 4) from that transfer to final load level. A signal from the vertical ejector pump and a confirming pressure signal from the turbine seals trigger the computer, which then calculates the spent fuel every 15 min throughout each stage of the starting process. All numerical coefficients, different for each stage, take into account fuel spent on plant auxiliaries. Calculations have been made for startup after various shutdown periods, ranging from shorter than 10 h to longer than 90 h and from the cold state. Tables 1. [80-2415/12947]

EFFECT OF LEAKAGE ALONG MAIN PASSAGE IN K-300-240 TURBINES ON THEIR ECONOMY

Moscow ENERGETIK in Russian No 9, Sep 84 pp 4-5

NOVIKOV, N. N., engineer, LAZUTIN, I. A., engineer, KULKOV, E. I., engineer, TARASHCHUK, M. G., engineer, and ZAKHARENKO, V. S., engineer, Belorussian Regional Administration for Power Equipment Maintenance and Repair

[Abstract] Tests were performed on three K-300-240 Leningrad Metal Works steam turbines for the purpose of determining the variations of internal efficiency in their high-pressure and medium-pressure stages during operation as well as after overhaul, with or without regeneration. Leakage of steam has been found to result in deviations of actual efficiency from the nominal one and also to have a significant effect on turbine economy. Leakage at runner blades was measured behind the 9th row (high-pressure cylinder) and behind the 16th row (medium-pressure cylinder) on the basis on steam temperature readings at the axis in the main stream and between shrouds. These measurements revealed a surprisingly high leakage rate of 30-50 t/h after overhaul, especially in the high-pressure cylinder, this rate fluctuating widely over the first 17 months and eventually diminishing to near zero over the subsequent 7 months. This indicates partial or complete clogging of clearances and of gaps in split couplings. In the medium-pressure cylinder too, provided that the seals remain stable, leakage along the main passage is dominant. Axioradial seals have no effect on the leakage over straps and thus on the steam economy in either turbine stage. Figures 1. [80-2415/12947]

NUCLEAR ENERGY

UDC 621.311.25:621.472.621.31.002.51.002.72

TECHNOLOGY OF EQUIPMENT INSTALLATION IN SES-5 EXPERIMENTAL SOLAR ELECTRIC POWER PLANT

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 49-50

DROB, Yu. G., engineer, and SHERMAN, I. M., engineer

[Abstract] The experimental semiindustrial 5 MW solar electric power plant operating near Kerchi in the Crimea consists of a circular heliostat panel split into four quadrants, a steam generator on top of a tower at the center, a steam turbine with an electric generator, and a heat storage for diurnal heat load equalization. Steam can be generated at a rate of 28 t/h at 250°C under a pressure of 4 MPa in a drum with natural circulation, with 14 evaporator panels and 2 tubular economizer panels. The tower is 80 m tall, a 23 m high cylindrical segment 4.5 m in diameter on top of a 66 m high conical multilegged base with a 10 m diameter on the ground. The tower contains 500 tons of metal. The plant was developed under the guidance of the Institute of Power Engineering imeni G. M. Krzhizhanovskiy and designed principally at the Riga department of All-Union Institute of Atomic-Heat-Electric Power Plant Planning and Construction, with the air of several subcontractors. Figures 2; tables 2.

[108-2415/12947]

UDC 621.311.23:621.438.621.221.3

BASIC DESIGN SOLUTIONS FOR ADVANCE AIR-STORAGE GAS-TURBINE ELECTRIC POWER PLANT

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 47-48

KALGANOV, D. G., engineer, CHEMISOV, B. A., engineer, and TKACHEV, V. V., engineer

[Abstract] Plans are made in the Soviet Union to build and install an advance 1050 MW air-storage gas-turbine electric power plant for power delivery during load peaks and power utilization during load dips. The basic unit in such a plant is a turbogenerator, the turbine consisting of two stages with a common

combustion chamber and a heat duct for each stage as well as a compressor mounted on each, also a custom-made 120 MW electric drive. Special attention has been paid to construction of the underground air storage with a capacity of $1.5 \cdot 10^6 \text{ m}^3$. Porous water-bearing rock into which the necessary volume of air can be pumped under the necessary pressure, with the volume of water 10 times larger than the air requirement, is preferable to salt deposits requiring eluviation and to hard bedrock requiring excavation with explosives. The plant will house three turbine sets and five compressor sets. The number of compressor sets can later be reduced to three, one set mounted on each turbine, when more powerful compressors with 330 kg/s rating become available. This will result in an overall reduction of the amount of plant auxiliary equipment. A transverse arrangement of sets is preferable to a longitudinal one and will be considered in the second generation of such electric power plants. Figures 1; tables 2; references: 2 Russian.

[108-2415/12947]

UDC 629.123.4/014.22

OUTLOOK FOR USE OF WIND ENGINES ON CARGO VESSELS

Leningrad SUDOSTROYENYE in Russian No 12, Dec 84 pp 10-13

ALCHUDZHAN, G. A. and MIROSHNICHENKO, I. P.

[Abstract] The feasibility of employing wind engines with sails as auxiliary propulsion system on medium-tonnage tankers and low-tonnage barges ("Sedov") has been evaluated on the basis of sail, load, and traffic data. First was determined the ship power or speed at 0-180° course angles relative to the wind direction, at various wind velocities and with wind drift as well as aerodynamic drag taken into account. Next the ship power or speed was calculated by the holo-probability method. Final and crucial consideration was given to the economics of wind engine, the average-per-voyage fuel economy in the companion thermal propulsion system serving as principal criterion. This economic analysis was based on the performance of a medium-tonnage tanker sailing from the Baltic Sea or the Black Sea to Cuba, a medium-tonnage bulk carrier sailing from the Baltic Sea or the Black Sea, or from the Far East (through the Panama Canal) to Cuba, and a low-tonnage tanker serving the coast of the Caspian Sea. The results are presented in terms of fuel saving, tons per passage and tons per year, and in terms of percentage relative to fuel consumed by steamship. This percentage ranges from 10.0% to 29.0%. Tables 2; references 5: 4 Russian, 1 Western.

[179-2415/12947]

UDC 629.12.001.11:539.4

REDUCED STRUCTURAL ELEMENTS FOR ANALYSIS OF SHIP STRENGTH AND VIBRATIONS

Leningrad SUDOSTROYENIYE in Russian No 11, Nov 84 pp 9-13

VORONENOK, Ye. Ya., PALIY, O. M. and SOCHINSKIY, S. V.

[Abstract] The method of reduced elements is proposed for analysis of ship strength and vibrations, in preference to other methods such as finite elements, superelements, and modular elements. The advantage of reduced elements are more efficient and economical algorithms, especially for

structures with one dimension much larger than all the others. The mathematical formulation of this method involves representing the complete displacement vector q for all subassemblies as the union of two vectors q_S and q_p , the former containing displacements of all joints and the latter containing displacements of all interstices. These two vectors are interrelated interpolationally through an approximating matrix S subject to various constraints, namely $q_p = Sq_S$. The physical formulation of the method includes the constraint of continuity on displacements over the entire boundary between any two reduced elements. The rows of the approximating matrix S are most expediently expressed in terms of continuous piecewise-polynomial functions of the boundary coordinates, with Lagrange polynomials in the interpolation splines. Construction of such a matrix is demonstrated on the simple example of a square plane element, ensuring that the requirement of completeness has been satisfied. The next steps are construction of the stiffness matrix for a reduced element from the stiffness matrix for the original element and then formalizing the principle of equal work of external forces. Otherwise the procedure is analogous to that in the method of finite elements. The algorithms of subsequent strength and vibration analysis have been programmed in FORTRAN for a BESM-6 high-speed computer. The authors' program VIBMF can be supplemented by other available programs such as AIMAZ (written by A. Yu. Baburin) and ASTRA for inclusion of special ship components in the analysis. Vibrations in the "Krym" tanker, with T-beams formed by joining a rack to a base plate, were calculated according to this method by A. L. Nakorenok. Figures 7; references 10: 5 Russian, 5 Western (1 in Russian translation). [121-2415/12947]

UDC 681.518.3

APPARATUS FOR MEASURING HIGH TEMPERATURES

Leningrad SUDOSTROYENIYE in Russian No 11, Nov 84 pp 24-25

BANNIKOV, A. I.

[Abstract] An apparatus for measuring high temperatures and fast changing temperatures is available which combines reliability of primary data gathering with minimum time lag in data processing. This KITM-3 apparatus includes, in addition to a set of inert thermocouples and thermal flux transducers, a signal corrector with three channels per thermocouple which not only reduces the time lag but also widens the frequency range of measurements. The corrector continuously feeds to the measuring circuits a compensating signal proportional to the inertia of the thermocouples. Its operation is based on differentiating the transient response function of an inert thermometer, taking into account the dynamics of heat balance between the sensing element and the surrounding medium whose temperature is measured. The corrector can operate in one step or in two steps. It also calibrates each measuring channel with precise bipolar periodic reference signals, square voltage pulses of adjustable amplitude, duty cycle, and repetition rate. Interference immunity is ensured by appropriate switching of internal and external circuits

and shielding of other instrument components. A microprocessor facilitates synchronous processing of output signals from variously corrected channels. A programmable manipulator module controls insertion of thermocouples into the test zone and their withdrawal from it prior of catastrophic overheating. Several interchangeable variants of this manipulator module are available for specific applications. The KITM-3 apparatus is designed for temperatures up to 4500 K and frequencies of temperature variation up to 500 Hz, one measurement cycle being completed in 0.08 s. The equipment is produced on small semicommercial custom-made basis. Figures 2; tables 1; references: 4 Russian.
[121-2415/12947]

CONSTRUCTION

UDC 621.315.1

COMPACT 330-500-750 kV OVERHEAD ELECTRICAL TRANSMISSION LINES ON 'ENCLOSING' SUPPORTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 4, Jul-Aug 84 (manuscript received 16 Sep 83) pp 3-11

LYSKOV, Yu. I., KURNOSOV, A. I. and TIKHODEYEV, N. N., Leningrad

[Abstract] Compactness of overhead superhigh-voltage transmission lines is a major prerequisite for achieving a higher load capacity and reducing the installation cost. Extensive studies of the compaction problem by N. N. Tikhodeyev and others have revealed that the most effective way to reduce the overall width of a line is to eliminate the metal struts on the supports between center phase and both outer phases. The distance between phases on the supports can then be reduced as much as "galloping" of conductors along the spans will allow without causing flashover. This concept was implemented in the design of "enclosing" transmission supports with the conductors of all three phases suspended symmetrically inside the portal, the latter formed by inward or outward sloping poles supporting the crossbeam and anchored by guys or erected as self-supporting trusses. At least 16 variants of this concept have been laid out, specifically for 500 kV lines and for 750 kV lines or equally suitable for both. The electrical design, aimed at optimizing the performance characteristics of the transmission lines, involves appropriate configuring and dimensioning of the phases and their conductors. The structural design is aimed at providing adequate mechanical support with the minimum amount of steel. The results of analysis and calculations indicate that it is possible, without adding more steel, to narrow down the strip of land under 330-750 kV transmission lines to be cleared for supporting structures to two thirds or even one half of what it is for conventional ones. Figures 5; references 4: 3 Russian, 1 Western.

[57-2415/12947]

PROTECTIVE POLYMER COATINGS FOR REINFORCED-CONCRETE PRODUCTS

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 73-74

KRIVOV, E. A., candidate of technical sciences, and SHARDAKOV, V. K., engineer

[Abstract] A technology has been developed at the Odessa Institute of Structural Engineering for both protective and decorative coating of reinforced-concrete surfaces. The basic facing and binding materials are ED-16 and ED-20 epoxy compounds, to which are added 20-70% modifier (polyether, carbamide, melamine-formaldehyde, or latex resin), 10-14% hardener (polyethylenol amine), 0-200% ground sand, and 0-2% pigment powder or paste. Specimens of concrete with a 1:2.1:3.8 cement-gravel-sand composition and a 0.45 water-to-cement ratio were coated on top, side, and bottom surfaces. Kerfs were cut after the 28-day curing period and the specimens were tested for adhesive strength of coatings. The binding underlayer was found to strengthen the polymer-concrete interlinkage. The necessary adhesive strength was attained on all surfaces, but with a larger margin on the bottom surfaces. The results reveal also that the thickness of the undercoating decreases as the mobility of the concrete mix after curing and setting, caused by excess water, increases. Such polymer coatings on concrete surfaces were further tested in a weather chamber simulating conditions to which deck and ceiling or roof slabs may be exposed. No damage was found after 500 h, and in a chemically aggressive medium such as sulfuric acid the strength of concrete did not decrease after 72 days. Figures 1; tables 3.

[108-2415/12947]

UDC 621.165:621.313.322-81:624.153

PREDICTING DYNAMIC CHARACTERISTICS OF FRAME FOUNDATIONS UNDER LARGE TURBINE SETS

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 68-69

AGRANOVSKIY, G. G., candidate of technical sciences

[Abstract] Four groups of experimental reinforced-concrete beams up to 4100 mm long, three beams in each group of given length, were tested for their vibration characteristics. The composition of the concrete was 330 kg cement + 480 kg gravel + 825 kg sand + 120 l water per cubic meter. The beams were reinforced with four class A-II steel rods 16 mm in diameter, two in the tension zone and two in the compression zone, and with stirrups through circular fittings 6 mm in diameter spaced 200 mm apart. The test data and their analytical evaluation reveal how the characteristics of reinforced concrete, namely its dynamic modulus of elasticity and logarithmic decrement of vibration amplitude, depend on the mode of cracking and on the seepage of

machine oil. These relations can serve as a basis for predicting and controlling the dynamic characteristics of frame foundations under large turbine sets. In the study participated engineer B. V. Slovesnyy. Figures 1; references: 1 Russian.
[108-2415/12947]

UDC 621.315.66

RATIONAL SELECTION OF ANCHOR-PILE DESIGN FOR STEEL POLES CARRYING OVERHEAD TRANSMISSION LINES IN PERMAFROST REGION

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 10, Oct 84 pp 22-25

SOLODOVNIK, V. Ya., engineer, SYCHEV, P. V., engineer, and SOLODOVNIK, Ya. V., engineer

[Abstract] Five different designs of reinforced-concrete anchor piles are considered for steel poles carrying overhead transmission lines in the Far North permafrost region. All designs take into consideration seasonal variations of the depthwise temperature profile in permafrost soil, as far as the anchor piles are to be driven. All piles are designed to fit into 400-500 mm wide holes in the ground. Three of the designs are most economical, one with a hinge-lever mechanism and two modifications with strips of a metal cap at the bottom profiled into a dovetails so as to facilitate hingeless unfolding. Horizontal slabs fastened to the dovetails cut into the soil while the latter are still in vertical folded position. Such anchor piles should replace 325 mm wide and 8 mm thick metal tubular ones which have not prevented falling of steel poles along the 220 kV Nadym-Pagody transmission line and the 110 kV Urengoy-Buran transmission line. Figures 1; tables 1; references: 4 Russian.
[108-2415/12947]

UDC 621.31.002.2:621.165:621.313.322-81:624.15

PREFABRICATED MONOLITHIC FOUNDATION UNDER ADVANCE 1000 MW TURBINE SET

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 65-68

LITVIN, I. S., engineer, RYBAKOV, S. N., engineer, SHUMAN, Ye. V., engineer, and SVERDLOV, P. M. [deceased], engineer

[Abstract] A prefabricated monolithic foundation has been designed for the advance 1000 MW K-1000-60/3000+TVV-1000-2 turbine set to be installed in AES's. The foundation accommodates the special layout of the new turbine, which differs appreciably from that of conventional 1200 MW turbines. It consists of four low-pressure stages spaced zonally and symmetrically on both sides of the high-pressure stage at the center and it has four transverse condensers instead of the usual two longitudinal ones. Outboard bearing

supports rest directly on the foundation, at the center between the two housing frames so as to ensure an even load distribution. The foundation design was developed at the Leningrad department of the All-Union Institute of Atomic-Heat-Electric Power Plant Planning and Construction, on the basis of experience with the K-1200-240-3+TVV-1200-2 turbine set in the Kostroma GRES. Such a foundation is being laid in the Rovno AES (power unit No 3), in the Khmelnik AES (power unit No 1), and in the Krymsk AES (power unit No 1). The foundation in the Rovno AES will be tested dynamically under the turbine set after completion of the project. Figures 4; tables 2.

[108-2415/12947]

UDC 621.311.25.621.039.69.05

FOUNDATION FOR HEAT EQUIPMENT IN CONSTRUCTION WORK AT BALAKOVO AES

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 15-17

GOLDIN, V. D., engineer, and IVOV, A. A., engineer

[Abstract] A foundation for heat equipment needed in construction work at the Balakovo AES has been designed at the Kuybyshev branch of the All-Union Institute of Power Plant Construction Planning and Organization (Orgenergostroy), according to specifications for VVER-1000 MW water-moderated water-cooled reactors. These specifications had been developed at the Kiev branch of the All-Union Institute of Power Plant Design and Erection (Energomontazhproyekt). The foundation areas have been enlarged so as to accommodate argon and oxygen supply and storage tanks as well as compressors needed for construction work, in addition to pipes and tools handled by 1500-2000 persons working on the project. Figures 1.

[108-2415/12947]

UDC 69.002.2

CONTAINERIZED COMPRESSOR PLANT SKK-70

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 29-30

CHESTNYKH, A. A., engineer, NATANSON, V. A., engineer, and KUVSHINOVA, L. N., engineer

[Abstract] A containerized compressor plant has been designed at the All-Union Institute of Power Plant Construction Planning and Organization (Orgenergostroy) jointly with its design and manufacturing engineering department in Volzhsk, for use in any factory or workshop. It consists of five separate transportable metal containers with complete equipment ready to deliver up to 70 m³/min of compressed air, two main ones 13x3x2.6 m³ large and two reserve ones 13x3x1.3 m³ large meeting safety requirements. Each

container is enclosed by roof and "sandwich" wall panels. Each of the VYe-18/9M1 2-stage compressors in this SKK-70 plant, produced at the Moscow "Kompressor" manufacturing plant, has a capacity of 17.5 m³/min. The plant can be transported to its destination by railroad or truck, on six platforms carrying all containers as well as a water cooling tower and a blow-through tank. The cost of this plant is 103,300 rubles, the cost of producing 1 m³ of compressed air is 0.28 kopek. Figures 1; tables 2.
[108-2415/12947]

UDC 658.21.003.12.001.12:69.002.2

WAYS TO LOWER COST AND SHORTEN CONSTRUCTION TIME OF AES'S FOUNDATIONS

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 84 pp 6-10

GELMAN, Ye. A., engineer

[Abstract] A line of temporary equipment and buildings necessary for completing the structural base of AES's with VVER-1000 MW water-moderated water-cooled reactors has been selected jointly by the All-Union Institute of Power Plant Construction Planning and Organization (Orgenergostroy), the All-Union Institute of Atomic Power Plant Structural Design (Atomenergostroyprojekt), the All-Union Institute of Power Plant Design and Erection (Energomontazhprojekt), and the State All-Union Special Design Engineering Office for Power Plant Protective Structures (Soyuzenergozashchita). The purpose is streamlining the foundation work so as to reduce the cost and to accelerate the operations, on which scheduling of all other subsequent work such as installation of power generating equipment and erection of permanent buildings heavily depends. The goals are technological modernization and standardization, involvement of all interested governmental departments and industrial as well as scientific-technical enterprises, and smooth integration into the country's socio-economic fabric. The organization of foundation laying and the list of temporary structures are based on experience in four existing AES's (Rostov, Balakovo, Khmelnik, Zaporozhye). The list was approved in 1983 by the Main Administration of Industrial and Technical Construction Management. Figures 1; tables 2.
[108-2415/12947]

INDUSTRIAL TECHNOLOGY

UDC 621:65.011.56

MACHINING MODULE FOR AUTOMATED PRODUCTION FACILITIES

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9,
Sep 84 pp 1-3

VORONTSOV, V. I., Engineer

[Abstract] A flexible automated machining module for workpieces with dimensions of up to 250 x 250 x 200 mm is described. The machining module incorporates a model 243VMF2 vertical boring mill, a model 6904VMF2 horizontal boring mill, a workpiece handling system, an automated device to interface with the boring machines, a remote-controlled automated transporting manipulator and an electronic computing system. These flexible computer-control machining modules can be used as the basis for designing and implementing flexible production systems (sections, shops and plants) employing the machine tools and machinery for batch and series production.

[6900-102/12947]

UDC 621.65.011.56

ROBOTIZED TECHNOLOGICAL SYSTEM FOR SWAGING PARTS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9, Sep 84
p 3

LETSIK, V. I., Candidate of Technical Sciences

[Abstract] A robotized technological complex for cold drawing, hole punching and swaging of parts is described. The complex incorporates a swaging punch, an ETsPU6030 electronic cycle program device, a parts ejector, a die, a rotating table, a vacuum clamp, a vibration hopper loader, a receiving bin and an MP-9s industrial robot. Three of these complexes are served by a single operator, whose duties are to load the blanks into the hoppers, to remove the bins full of finished parts and to monitor the operation of the system. The implementation of three of these systems made it possible to release two workers and to obtain annual savings exceeding 3,000 rubles.

[6900-102/12947]

UDC 621.9.06-52:658.527: 62-229.7

ROBOTIZED TECHNOLOGICAL LINE

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9, Sep 84
p 4

ZALESNYKH, L. B., Engineer

[Abstract] A robotized technological line based on model 1716Ts semi-automatic duplicating lathes employing cycle program control and PR-10I industrial robots is described. The line, which is used for rough and finished turning of the centers of shaft-type parts, incorporates two modules, a loading conveyor, and intermediate conveyor and an unloading device. The operating cycle of the device is traced from beginning to end. The system can handle parts up to 400 mm long and 22 mm in diameter at a rate of up to 50 pieces per hour. The system requires a single operator per shift.
[6900-102/12947]

UDC 621.313.713(088.8)

ELECTRODYNAMIC MOTOR FOR INDUSTRIAL ROBOT

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9, Sep 84
pp 17-18

LITVINENKO, A. M., Candidate of Technical Sciences

[Abstract] This study presents experimental material from investigations of prototype electrodynamic drives employing a reciprocating motor operating on a basis of the electrodynamic interaction between antiparallel currents. The experimental setup used to determine the acceleration characteristics of the motor described. The motor was found to exhibit a steeply rising characteristic over intervals of less than ten seconds, caused by electrodynamic interaction, as well as a gradually rising characteristic over intervals exceeding ten seconds caused by linear expansion of the aluminum foil active element due to heating by the current passing through it. The use of a multilayer active element to improve energy indicators, especially internal friction losses, is discussed.
[6900-102/12947]

UDC 62-83

LINEAR ELECTRIC MOTORS FOR IN-SHOP TRANSPORTING DEVICES

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9,
Sep 84 pp 18-21

KRAPIVIN, V. S., Candidate of Technical Sciences

[Abstract] The use of reactive linear step electric motors to power in-shop transporting devices is discussed. A three-phase sectional linear electric motor is described that can be used for in-shop overhead and floor-mounted transportation systems. A second linear step motor is examined which eliminates unilateral attraction by employing a transverse magnetic field. Motors with transverse magnetic fields provide good tractive force, but must incorporate at least a five-phase design. Permanent-magnet suspensions are compared with electromagnetic and self-centering electromagnetic suspensions.
[6900-102/12947]

UDC 681.327.22

ORGANIZATION OF DATA BASE FOR AUTOMATED INFORMATION SYSTEM

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9,
Sep 84, pp 32-33

MOZOLEVSKIY, I. Ch., KLEVECHKA, R. K. and RAGUTSKAS, V. I. A., Engineers

[Abstract] Database organization with the help of simulation is analyzed. The database of the automated information system consists of five files: an index file, two inverted list files, an object file and a concept file. Entry into the database is achieved through the index file. A description is given of a model of an automated information system setup to investigate the operating time of the individual blocks of the database and determine the average response time and time elapsed prior to initial output of data to the terminal screen. On the basis of the simulation, recommendations are given for improving the physical structure of the database in order to reduce the data output time by as much as a factor of two. The use of simulation in the design phase makes it possible to reduce software development costs significantly, and to speed up the development of automated information systems with the required temporal characteristics.
[6900-102/12947]

UDC 62.529: 65.012.2

EXPERIENCE IN IMPLEMENTING DATA PROCESSING SOFTWARE AND INFORMATION SUPPORT
FOR SHORT-RANGE FORECASTING

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9,
Sep 84 pp 33-35

YUSUPOV, R. Kh., Engineer

[Abstract] This study addresses the problem of software maintenance for automated data processing systems for short-range forecasting. A set of interpreter programs is described which insure that the short-range forecasting data processing system remains functionally stable when the structure of the GSS [budget system] changes, when the forecasting methods change, when the functional capabilities of the data processing system change, and when other external user requirements change.

[6900-102/12947]

UDC 621:65.011.56: 65.012.7

AUTOMATED VERIFICATION OF DATA SECURITY IN MANAGEMENT INFORMATION SYSTEMS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9,
Sep 84 pp 35-37

RUDZITSKIY, B. M., Candidate of Economic Sciences

[Abstract] This article describes an approach to automated checking of data security for management information systems operated by major organizations. A comparative analysis is made of the basic procedures for confirming the authenticity of users and data system components: the use of passwords, the establishment of interactive working, the performance of conversion functions, the checking of individual characteristics and the formation of physical connections. The establishment of device authenticity, in addition to user authenticity, is discussed.

[6900-102/12947]

UDC 621.865.8:621.984.3.016.3

ROBOTIZED SEGMENT OF SHEET STAMPING OPERATION

Moscow MASHINOSTROITEL in Russian No 11, Nov 84 p 10

LISITSYN, V. A., Engineer, KHOLOSTOV, K. M., Engineer, MARTYNOV, V. P., Engineer, and RASHEVSKAYA, N. A., Engineer

[Abstract] Robotization of a segment of the cold sheet stamping operation is proposed, a segment which handles 0.8-2.0 mm thick, 10-50 mm wide, and 20-76 mm long blanks weighing up to 0.1 kg. The productivity is to be 720-900 pcs/h, a 220 V - 50 Hz electric power line and compressed air under a pressure of 0.4-0.6 MPa being required for operation. A major feature of this robotized segment is separation of two complexes, one for single-position stamping and for two-position stamping. The robot manipulators have respectively one electromagnetic tong and two electromagnetic tongs, for picking up blanks from the hopper after automatic orientation and piecewise feed of blanks into position. After stamping, an air blast dumps finished parts into a bin. A single operator attends to both complexes and to hopper loading. Tables 1.

[122-2415/12947]

UDC 621.869.4-83

EXTENDING TECHNOLOGICAL VERSATILITY OF HOIST TRUCKS

Moscow MASHINOSTROITEL in Russian No 11, Nov 84 pp 11-12

ZYABKIN, A. Ye., Engineer

[Abstract] A crane arm with hook and 200 kg load capacity for the EP-1201 electric hoist truck has been developed at the Mogilev Design and Manufacturing Engineering Institute of Automobile Machinery. It is hinged to the cantilever bracket at the free end of the latter at the free end, this bracket being rigged to the truck at the other end. The hinge joint is formed by a pin through the bracket and through the crane arm underneath, retained on both sides and with a hook at the lower end designed for a 300 kg load capacity of the bracket alone. The arm, constituting an extension of the bracket, can be rotated through a complete circle clearing the bracket when passing under it. On the pin is also mounted a brake sheave for locking the crane arm in position. The brake is always enclosed and consists of two levers hinged to the housing with brake shoes at the free inner ends. The crane arm, which consists of two channel bars, not only facilitates handling of loads from or to otherwise inaccessible places but also extends the hoist capacity. Figures 1.

[122-2415/12947]

UDC 621.86.06(088.8)

LOAD GRIPPING DEVICES

Moscow MASHINOSTROITEL in Russian No 11, Nov 84 p 19

RAKHMANOV, N. N., Distinguished Inventor of UkSSR

[Abstract] Two new load gripping devices for hoists have been invented by the author. The first one (USSR Patent disclosure No 948,833) consists of two frames, one sliding through the other and both dropped or lifted with a locking mechanism, and two shoes symmetrically hinged to both frames each through either a three-bar mechanism in one version or a two-bar and slider mechanism in another version. The second one (USSR Patent disclosure No 1,082,747) consists of two identical straps, each including a rubber damping interlayer between two steel bands, joined together along their inner bands except for two eyelets and clamped together at the lower end by a bracket with a load carrying hook and at the upper end by a bracket of the hoisting mechanism.

Figures 2.

[122-2415/12947]

UDC 620.165.29.05

LOCKING FIXTURES

Moscow MASHINOSTROITEL in Russian No 11, Nov 84 pp 19-20

FILIMONOV, A. P., Engineer

[Abstract] An improvement of the already known locking fixtures for machining of parts (MASHINOSTROITEL No 3, 1981 p 36) is proposed (USSR Patent disclosure No 868,151). The part is mounted on the hollow shaft end of the machine tool, between the shaft shoulder and a snap ring slipped into a circumferential groove with its center tab passing through a diametral hole in the shaft. Figures 1.

[122-2415/12947]

UDC 621.941.1:621.822.72

TOOL FOR LATHE TURNING OF TRACKS IN BEARING RACES

Moscow MASHINOSTROITEL in Russian No 11, Nov 84 p 22

YABLONOVSKIY, L. S., Engineer

[Abstract] A tool with rack mechanism for tangential lathe turning (USSR Patent disclosure No 755,437), developed at the Zaporozhye Institute of Design

and Manufacturing Engineering, has been installed in the 1265PM-6 semiautomatic six-spindle machine tool at the State Ball Bearing Production Plant GPZ-10. The tool case is mounted on the support plate of the lathe and its shaft is coupled to a thrust rod, while being constantly pressed by a spring in the direction of axial feed. The shaft axis is offset relative to the race axis. The drive for circumferential feed, a hydraulic cylinder coupled through a rack and pinion to the tool shaft, is placed between guide shoulders cut in the tool case. Added features are a rotatable hydraulic cylinder (USSR Patent disclosure No 753,544) and a differential piston for quick return of cutter. Figures 1.
[122-2415/12947]

UDC 531.717.15

MEASURING PITCH DIAMETER OF INTERNAL THREADS

Moscow MASHINOSTROITEL in Russian No 11, Nov 84 pp 30-31

CHEKANOV, V. Ye., Candidate of Technical Sciences

[Abstract] In order to measure the pitch diameter of an internal thread within permissible tolerance limits, it is necessary to take into account the dependence of its variation on the variations of pitch and profile angle. On the basis of this relation is proposed an inspection gauge which includes two racks with threads on their outer surfaces nominally identical to the thread of the inspected hole and with flat surfaces on their inner sides. Two jaws with permanent magnets are placed pairwise on both lateral sides of each rack and the jaws of both racks are pairwise coupled through tie rods which orient the racks diametrically in the direction of the threaded hole. This fixture can be rotated and moved lengthwise through the hole, with another magnet controlling its position. First the lower rack and then the upper rack makes contact with the inspected thread. As the fixture is rotated and moved into the hole, the distance between the flat backs of the two racks varies from maximum to minimum, the difference between them indicating the hole ovality and the hole taper. This gauge is particularly suitable for inspecting the threads of large M200-300 nuts. Figures 1.

[122-2415/12947]

UDC 621.822.5

WEAR SELF-COMPENSATION EFFECT IN SELF-SEALING ANTIFRICTION BEARINGS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 287, No 6, Oct 84
(manuscript received 12 Oct 83) pp 1359-1363

MIKHIN, N. M. and SLYADNEV, M. A., Institute of Problems of Mechanics, USSR
Academy of Sciences

[Abstract] An antifriction bearing with self-compensation for wear consisting of a shaft, and a sleeve which fits over the shaft with guaranteed clearance, is investigated. The macroscopic clearance, defined as the distance between the surface of the shaft and sleeve due to microscopic surface irregularities, is eliminated, leaving only the microscopic lubricant-filled clearances. The influence of the absence of macroscopic clearance on the interaction between the shaft and sleeve is investigated. The distinguishing features of the bearing with self-compensation for wear are compared with ordinary bearings operating under conditions of boundary lubrication. The operation of bearings with bronze or tin sleeves and construction steel shafts is investigated experimentally. It is found that self-sealing antifriction bearings with automatic wear compensation are more than three times as resistant to wear and small friction losses than ordinary bearings. References: 4 Russian.

[78-6900/12947]

UDC 621.753.1:513.734.1

ACCURACY OF MATING CYLINDRICAL SURFACES FOR DETERMINATION OF DIAMETERS WITH ADEQUATE ACCOUNTING FOR SHAPE IMPERFECTION

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 51-52

VAYKHANSKIY, S. M., Engineer, MARKOV, N. N., Doctor of Technical Sciences, and PANIN, G. I., Candidate of Technical Sciences

[Abstract] The problem of accounting for shape imperfection of mating cylindrical surfaces in assembly of parts such as pin-hole or plunger-sleeve pairs with small clearances is analyzed from the standpoint of accuracy and tolerances ensuring the minimum possible reject rate. Use of cylindrical gauges, with dimensional characteristics allowing for the manufacturing imprecision of mated parts, brought into contact with mating surfaces prior to assembly is found to improve the productivity of the assembly process when compared with two other methods of matching before assembly. The improvement is moderate over matching by measurement of local diameters and thus determination of each type of shape deviation. The improvement is appreciable over matching by determination of the smallest local hole or sleeve diameter and the maximum local pin or plunger diameter, the reject rate in this case being typically reduced from 8% to 0 on the basis of fit and slidability as acceptance criterion. Tables 1; references: 6 Russian.

[197-2415/12947]

RATIONAL DESIGN OF FRICTIONAL DAMPERS FOR VIBRATION SUPPRESSION IN AUTOMATIC PRODUCTION MACHINE MECHANISMS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 21-23

TELEGIN, V. V., Engineer, TARNOVSKIY, V. I., Doctor of Technical Sciences, and LUGOVOY, E. P., Candidate of Technical Sciences

[Abstract] The design of frictional dampers for vibration suppression in automatic-production machines is analyzed on the basis of an appropriate kinematic model and the system of differential equations describing its motion. The model is a lumped damper mass with elastic-dissipative couplings to the multimass vibrating mechanism and an elastic-dissipative coupling to the frame or base. The design of a real damper requires establishment of the conditions which will ensure no locking and calculation of the friction force or moment which will ensure maximum dissipation of energy. The three principal damper parameters, namely its mass m_0 and stiffness c_0 and its normal pressure force F_N on the friction surface, are then determined rationally upon introduction of the generally nonlinear target function $f(F_N, m_0, c_0) = \int_0^T \mu(t)(x_1 - \bar{x}_1)^2 dt$ equal to the integral of damper deviation

from ideal mechanism trajectory over one cycle of machine operation. This target function must be minimized, taking into account any constraints imposed by the vibrating machine mechanism and necessarily using numerical methods for this not analytically solvable problem. A damper for an AV-1918 automatic cold-upset forging machine has been designed according to this procedure. Transient processes and dynamic characteristics were calculated assuming, for simplicity, elastic and massless piecewise-linear couplings between the lumped damper mass and the equivalent two lumped masses of the mechanism. With high accuracy of mechanism positioning required initially only and much less accuracy needed during the remaining time of an operation cycle, it was feasible to let the driving function be $\mu(t) = \frac{10}{2}t^2 + 1$. Results obtained on a YeS-1022 computer have been validated by measurement of vibrations with and without damper. Figures 3; references: 4 Russian.

[197-2415/12947]

DYNAMIC TESTING OF PLASTIC AUTOMOBILE WHEELS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 23-25

KARNAUKHOV, B. G., Engineer, and BELOV, A. I., Candidate of Technical Sciences

[Abstract] According to theoretical analysis, an automobile wheel made of glass-filled polycarbonate has the same mechanical strength as one made of steel. Experimental verification requires testing, which is done most

economically in the laboratory by an accelerated method combining simulation and statistical analysis. Several such methods are currently used, but no comprehensive one has yet been certified. Static strength is measured by filling the tire with a liquid instead of air so as to build up a very high gauge pressure, inside a safety chamber. Fatigue strength is measured by application of a cyclic load at the rim of a stationary wheel mounted in a stand, either concentrated at one point moving around the rim circumference or distributed around the rim circumference and pulsating at all points. Fatigue testing with a counter-spinning drum is least adequate, because of the low load capacity and the high wear. Much more effective is spinning the wheel fastened around one flange to a disk and loading it through a lever arm at an angle so that an axial force as well as a bending moment are produced. Here not only the wheel can be spun but also the load vector can be rotated, by rotating an unbalance mass or by harmonically sliding two pistons in their respective hydraulic cylinders 90° out of phase with one another. Data from these tests are then statistically analyzed and extrapolated to real motion of an automobile on a road along a curvilinear trajectory simulating most severe conditions. This has been done semiempirically for a VAZ automobile with wheels made of Macrolon 8344 glass-filled polycarbonate, using fatigue and wear data on this material available from the Plastics Division of General Electric Co. Wheels made of this material were then also tested on proving grounds, on asphalt pavement with bumps and pot holes as well as on snow and ice, at speeds up to 180 km/h and at ambient temperatures from -30 to +40°C. The wheels were found to be so reliable, with no deterioration of performance even under the most adverse conditions, that this material can be recommended to the Soviet automobile industry for controlled production.

Figures 3; references: 1 Western.

[197-2415/12947]

UDC 621.833.6.001.2

EXPERIMENTAL STUDY OF TWO-STAGE PLANETARY GEAR TRANSMISSION

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 11-12

ARNAUDOV, K. B., Candidate of Technical Sciences, KOSTADINOV, P. K., Engineer, DACHEV, N. S., Engineer, ATANASOV, G. Ts., Engineer, SANKOV, Z. B., Engineer, BINEV, A. M., Engineer and GEORGIYEV, G. T., Engineer

[Abstract] A special test stand has been built and installed at the Higher Institute of Electrical Machine Engineering in Gabrovo (Bulgaria) for experimental evaluation of the performance of planetary gearing, a particular concern being the load distribution between planet gears and a maximally uniform distribution being desirable. The test equipment consists of a constant-speed electric motor and a varidrive transmission, the latter driving a two-stage planetary gear transmission which runs as speed reducer and in turn drives a load, an electric generator, through a speed booster. The tested planetary gear transmission consists of two stages in series, with three planet gears in each and with idler-stud of the first stage rigidly coupled

to pinion of the second stage. Each planet gear, a narrow-hub spur gear, is mounted on a single-row ball bearing and the numbers of teeth of the three in each stage have been selected 24-120-48 so as to ensure complete repeatability of their relative position after a few revolutions with minimum but repeatable error. A full 9-factorial experiment can be and has been performed in this test stand, for determining the dependence of the load distribution nonuniformity on torque, speed, eccentricities, phasing, and axial distance between stages. These experiments have revealed that all nine factors influence the load distribution between planet gears in each stage. Its nonuniformity increases with higher speed and decreases with larger torque. The load distributes more uniformly in a synphasal assembly of planet gears and is always more uniformly distributed in the low-speed stage than in the high-speed stage. The load nonuniformity factor in the high-speed stage reaches an absolute maximum larger than 2, its ratio to the load nonuniformity factor in the low-speed stage being 1.32 for a synphasal assembly and 1.4 for an asynphasal one. Figures 4; references 8: 5 Russian, 3 Bulgarian.
[197-2415/12947]

UDC 621.757-52:621.9.06.002

CONSTRUCTION AND INTRODUCTION OF READJUSTABLE EQUIPMENT FOR MECHANIZATION AND AUTOMATION OF ASSEMBLY IN MACHINE-TOOL MANUFACTURE

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 59-62

ARKHANGELSKIY, Yu. S., Engineer, and FROLOV, Yu. S., Engineer

[Abstract] Assembly of parts in machine-tool manufacture involves preparatory operations and auxiliary operations in addition to assembly operations proper. This has been considered in mechanization and automation of the assembly process with the aid of readjustable equipment. Readjustable equipment necessary here is: 1) equipment for incoming inspection of electrical, hydraulic, pneumatic components as well as roller or ball bearings and V-belts; 2) equipment for preliminary handling of hydraulic and pneumatic pipeline tubes; 3) equipment for heating parts; 4) equipment for press-on and shrink-on; 5) single-rack and double-rack rotatable fixtures for assembly of spindles and high-pressure hoses; 6) fixtures for assembly of hydraulic and pneumatic cylinders. Such equipment has been developed at the Ryazan branch of the State Planning, Technological and Experimental Institute for Organization of Machine-Tool and Tool Industry. Model SR3531.11 for inspection and selection of V-belts is now operating in the Voronezh Machine Tool Manufacturing Plant. Model S3512.01 for assembly for electric motors (A02-52-8/4) with pulley or coupling plate is now operating in the Srednevolzhskiy Machine Tool Manufacturing Plant. Other readjustable stands are rotatable single-rack and double-rack models S7831-4009 and S7831-4008, model S3531.38 for inspection of "roller screw-and-nut" transmissions built at the Dmitrovsk Experimental Machine Manufacturing Plant, now operating in the Odessa Precision Machine Tool Manufacturing Plant and in the Moscow Precision Machine Tool Repair Plant. The universal model S3512.07 is now

operating in the Moscow Machine Tool Manufacturing Plant imeni S. Ordzhonikidze. The complete set of devices necessary for referencing, mounting, adjusting, correcting, clamping and fastening are built with interchangeable universal components in accordance with STP 1511.08-81 and STP 1511.153-81 standards of the Institute for Organization of Casting Machinery Industry. Figures 3; tables 5; references: 4 Russian.

[197-2415/12947]

UDC 621.865.8

TECHNOLOGICAL PROBLEMS IN DESIGN OF FLEXIBLE AUTOMATIC ASSEMBLY LINES

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 54-59

ZAMYATIN, V. K., Candidate of Technical Sciences

[Abstract] A flexible automatic assembly line is an essential subsystem of any flexible automatic production system, usually designed to cover several technological assembly modules with control through a single computer or a computer network. Accordingly, flexible automatic assembly modules constitute the second level in a flexible automatic production system--between assembly centers at the first level and overall automatic enterprise production output at the third level. The first overall problem in designing a flexible automatic assembly line is establishing the optimum automation level and flexibility level, which requires an analysis of projected product assortment and product volume as basis for both tradeoff and standardization. The next problem is programming the assembly operations for maximally efficient and economic use of robots. This problem is tackled in several ways: 1) adaptation of parts manufacturing processes for robotization of parts assembly; 2) standardization and unification of parts; 3) standardization and classification of processes; 4) modularization of robots; 5) development of adaptive and special-purpose robots; 6) standardization and unification of peripheral equipment, including dies and fixtures; 7) increasing the reliability of robots to within $(2-5) \cdot 10^6$ hours mean time between failures; 8) increasing the reliability margin of computer control to within $(1-2) \cdot 10^3$ hours; 9) increasing the assembly speed to 3 m/s or higher; 10) increasing the positioning accuracy to within 0.003 mm or better; 11) simplification of robot programming and training; 12) development of robots with more automatic manipulators and arms. The optimum design of an assembly robot combines the correct kinematic scheme with maximum simplicity, rectangular and polar-cylindrical systems of space coordinates being increasingly used for accurate positioning. Possible implementation of these concepts is demonstrated on typical assembly centers, one with conveyors for assembly of different kinds of parts and one with a table for assembly of one kind of part, each including trays and exchangeable tools in cartridges as well as a screwdriver. The final problem in designing a flexible automatic assembly line is accelerated industry-wide coordination of scientific and engineering support activity for earliest possible availability of necessary components. Figures 4.

[197-2415/12947]

UDC 621.941-115:620.1

MORE ACCURATE MEASUREMENT OF CYCLIC ERRORS OF HEAVY TOOTH CUTTING MACHINE TOOLS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 84 pp 20-21

IONAK, V. F., ABRAMYAN, E. S. and KULACHKO, P. M.

[Abstract] A method is proposed for more accurately measuring cyclic kinematic errors, specifically tooth cutting errors caused by vibrations in heavy machine tools. The method involves preliminary filtration of readout signals from the angle transducer which tracks rotation of the cutter stage. Vibrations of the pantograph-transducer system produce interference in the form of an additional transducer output signal. The latter and its effect on the phase shift of the transducer signal carrier are best analyzed with the aid of Fourier series expansion. Such an analysis indicates how effectively a passive RC filter with the photodiode will suppress the interference component. The effectiveness of this method has been demonstrated on a 543 milling machine tool with a KN-7U kinematometer before and after insertion of a filter with a 0.5 μ F capacitor, such a filter found to pass a 10 Hz signal without distortion and suppressing a 20 Hz or higher-frequency interference to one tenth of its level. Figures 1; references: 3 Russian.

[118-2415/12947]

UDC 681.26.08:519.2

DETERMINING EQUILIBRIUM POSITION OF BALANCE BEAM OF SCALES IN OSCILLATORY MODE OF WEIGHING

Moscow METROLOGIYA in Russian No 8, Aug 84 pp 26-30

TOROPIN, S. I. and SNEGOV, V. S.

[Abstract] Laboratory scales must not be overdamped when high precision is required and, therefore, the transient time will usually be much longer than the period of natural oscillations of the sensing element. The equilibrium position of the balance beam is then calculated from the readings of its extreme positions, rather than by integration of the input signal in the aperiodic case of less precise scales with damping and a very short transient time. Precision scales are being continually improved in design but so far not in the method of operation, even though the latter has two major drawbacks. These are the long reading time of many extreme positions and the error caused by high-frequency components of oscillation of the scale hangers in the pendulum mode. Integration of the space coordinate during one beam oscillation period is proposed as means of eliminating this error, taking into account that one beam oscillation period can be a very small fraction of total transient time and that the natural period of balance beam oscillations is not a whole multiple of the period of load scale oscillations. The theory of

this method is based on the equation of motion for the entire device as a linear mechanical system with n degrees of freedom. This equation is solved in general form, for all scales of this kind, and in generalized coordinates with the aid of Fourier series expansion. The mean-integral beam angle within one period does generally not coincide with the equilibrium position of the beam and, therefore, a series of discrete angular coordinates must be read. This is feasible with modern instruments and available microprocessors suitable for automating the entire beam equilibrium determination. References 8: 6 Russian, 2 Western.
[117-2415/12947]

UDC 62-83:621.313.13-133.32

OPTIMIZATION OF ELECTRIC STEPPER MOTOR WITH LOCAL FEEDBACK

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 22 May 84) pp 63-68

KUDRYASHOV, B. A. and SMIRNOV, Yu. S., Chelyabinsk Polytechnic Institute

[Abstract] Efficient and precise stepper motors with programmed acceleration or fine step discretization are further optimizable, particularly with respect to interference immunity and stability, by means of principal angle feedback using microelectronic circuits. The feasibility is demonstrated on a contactless d.c. motor operating in the self-commutation mode. The design requirements for such a motor with locally closed feedback loop are determined from the equation which describes its mechanical performance characteristics, assuming a lossless torque conversion by an ideal speed reducer but taking into account internal damping. Specifically, the optimum commutation angle and gear ratio for a given output speed are calculated. This is done by differentiating the torque separately with respect to each of these two variables and then equating the respective partial derivatives to zero. The results indicate that the optimum commutation angle for maximum output power does not depend on the load speed and torque but is determined by the ratio of dimensionless electrical time constant of the motor winding to dimensionless damping coefficient. Losses in the speed reducer are, indeed, negligible as long as that ratio remains low, but become significant as this ratio decreases in the underdamped case. Article was recommended by Department of Automation and Remote Control. Figures 2; references: 4 Russian.

[127-2415/12947]

UDC 536.53:621.382.33

MEASUREMENT ERROR OF TRANSISTOR TEMPERATURE SENSORS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 26 Oct 83) pp 79-82

KAGANOV, M. A., FOGELSON, I. B. and SHIKHOV, V. I., Scientific Research Institute of the Dairy Industry; Agrophysical Scientific Research Institute

[Abstract] This study presents the results of an investigation of the long-term stability of germanium and silicon transistor temperature sensors and special thermotransistors operating in the 250 - 370 K range as a function of the manner of connection and the amount of power dissipated in the sensor. The stability of the temperature sensitivity and dispersion of instability in batches of 50 - 100 like temperature sensors are estimated. The median long-term stability of MGTT108 thermotransistors are plotted as a function of temperature and operating time. It is found that there is no substantial relationship between long-term stability and amount of current dissipated, indicating that the influence of electrical current as one of the factors in temperature sensor aging is small as compared with other factors, such as temperature. The measurement error resulting from long term instability does not exceed ± 0.15 K/year for the first year in the 250 - 370 K range, and drops to ± 0.02 K/year in subsequent years.

[140-6900/12947]

UDC 536.24

OPTIMIZATION OF CONTROL OF MOVABLE HEAT SOURCE BASED ON NUMERICAL METHODS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 11 Mar 84) pp 73-79

KOLOMEYTSEVA, M. B. and MITROFANOV, V. Ye., Moscow Power Engineering Institute

[Abstract] This study investigates the optimal control of an electron beam used for heating in order to obtain the required temperature distribution. The problem is split into two interrelated tasks: the development of a method for determining the optimal parameters of the principle by which the source is moved and the synthesis of beam control devices. The first of these is solved by using numerical search methods employing a digital model of the object. Test calculations indicated good convergence of the search algorithms employing ordinary gradient methods. An optimal equation is derived belonging to the class of piecewise constant functions that significantly simplifies the synthesis of the control device. A piecewise-linear signal generator is described that provides the capability of controlling the rate of change of the signal invariantly in each linear segment. References: 4 Russian.

[140-6900/12947]

UDC 62-63:007.52:621.313.072.9

INVESTIGATION AND OPTIMIZATION OF ASYNCHRONOUS ELECTRIC DRIVES FOR INDUSTRIAL ROBOTS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 5 Apr 84) pp 44-49

LOSEVA, N. I., Murom Branch, Vladimir Polytechnical Institute

[Abstract] The construction and optimization of high speed asynchronous electric drives for Universal-5 and RPM-25 industrial robots are investigated. It is established through vector control principles and methods that the optimum control principle for the asynchronous motor in industrial robot drives is one in which the magnetic flux linkage is forced to a level 25% higher than rated by forcing the absolute value and frequency of the stator current vector. An asynchronous electric drive controlled by the minimum current as a function of the stator current vector is recommended for manipulators operating under extreme conditions. Closed frequency-current or phase-frequency current control systems employing the angular shaft position vector as the fundamental orienting vector are recommended for unified industrial robots. References: 6 Russian.

[140-6900/12947]

UDC 621.317

PERIODIC SIGNAL INTEGRATOR INCORPORATING AMPLIFIER ZERO-DRIFT COMPENSATION

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 22 May 84) pp 50-52

ZYKIN, F. A., PLOTNIKOVA, T. S., ZHELATELEV, S. G. and SIDOROV, V. A., Ulyanovsk Polytechnical Institute

[Abstract] This study describes a periodic-signal integrator that compensates automatically for operational amplifier zero-drift by means of direct current feedback. The circuit of the device is presented. A method is proposed for compensating periodic signal errors caused by feedback by adding a follower and transformer to the initial circuit. It is asserted, assuming that the transformer has the same transformation coefficient for all harmonics, that the proposed devices will integrate periodic signals exactly. References: 2 Russian.

[140-6900/12947]

UDC 681.325.65

ALGORITHM DETERMINING A CONNECTION LIST FOR A COMPUTER DESIGN

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 16 Apr 84) pp 29-34

POLYAKOV, V. I., Leningrad Institute of Precision Mechanics and Optics

[Abstract] This study investigates different ways of constructing the list of interconnections that must be made when designing the placement of components and routing of connections in designing computing equipment. The algorithm consists of finding the set of essential edges and building trees with maximum weight for each chain. The algorithm is based on the Quine-McCloskey minimization method. An example of the operation of the algorithm is presented. The algorithm can be used in computer-aided design systems for surface and printed wiring. References: 5 Russian.

[140-6900/12947]

UDC 681.322.01

ORGANIZATION OF PROCESSOR ORIENTED TOWARD MULTIPROCESSING

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 7 May 84) pp 23-29

GUZIK, V. F., ZOLOTOVSKIY, V. Ye. RESHETNYAK, V. N., Taganrog Electrical Engineering Institute imeni V. D. Kalmykov

[Abstract] A functionally distributed processor with hardware instruction implementation is described that incorporates an arithmetic-logic block, a multiplication block, a division block, an arithmetic expander for shift, bit, etc., operations, an elementary function block (sin, cos, etc.), random-access program memory, random-access data memory, a flag block for interaction between processes and a central controller. The use of these multiservice blocks makes it possible to reduce time lost to blocking of computational processes and to increase the speed of the processor. The software run on the processor is represented as a set of parallel branching segments, allowing the processor to support multiprocessing. The structure and functions of the basic blocks are described. It is found analytically that processors employing the proposed structural principle can be used successfully in computer systems for real time modeling and control. References 3: 2 Russian, 1 Western.

[140-6900/12947]

UDC 531.8

PROBLEMS OF MECHANICS OF ROBOT MANIPULATOR TONGS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 84 (manuscript received 19 Dec 81) pp 32-35

KOLPASHNIKOV, S. N. and CHELPANOV, I. B., Leningrad

[Abstract] The gripping of an object by a robot manipulator tong is treated as a problem of statics. The balance of forces and the balance of moments at discrete contact points are supplemented with appropriate relations of kinematics for small displacements. The tong is assumed to consist of two members, the upper one moving relative to the tentatively stationary lower one, and is required to rigidly clamp the object. The conditions for rigid clamping are established by relating such a constraint to stability of an equilibrium position and, accordingly, minimizing the potential energy as a function of generalized coordinates, with the potential energy expressed as a sum of linear forms rather in the "classical" quadratic form. Dry friction is taken into account in establishment of extreme states and the range of variation of kinematic parameters within which reliable holding of the object by the tong will be ensured. Figures 3.

[163-2415/12947]

UDC 531.8

DYNAMICS OF ELASTIC MANIPULATOR UNDER GIVEN CONTROL TORQUES OR DURING MOTION OF CARRIED LOAD

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 84 (manuscript received 12 Dec 83) pp 19-25

MIKHAYLOV, S. A. and CHERNOUSKO, F. L., Moscow

[Abstract] The dynamic characteristics of a manipulator are analyzed as those of a two-bar mechanism on the basis of an elastic mechanical model. Both bars are made of a homogeneous elastic material, they are straight and of equal lengths, each with an annular cross section and subject to bending as well as twisting. There are two cylindrical hinges in the fixed shoulder joint, the axle of one remaining stationary and the axle of the other being movable perpendicularly to the former. There is a cylindrical hinge in the elbow joint, its axle moving parallel to the movable axle of the second shoulder hinge as long as the upper arm is not elastically deformed. The load is regarded as a point mass in the hand, a mass larger than the manipulator mass. Elastic displacements of manipulator and load are assumed to be small in comparison with the length of each bar. Three torques are exerted on the manipulator carrying the load, each produced by a motor in each of the three hinges, and an external force acting on the load produces a reaction at the fixed shoulder point. The analysis of the dynamics is reduced to

solution of two problems: 1) for a given control law $M(t)$ for the torques in the hinges, find the motion $r(t)$ of the load and the angles of the hinges $\phi(t)$ as well as the force $\theta(t)$ of the load on the manipulator as functions of time 2) for a given desired motion $r = r^*(t)$ of the load, find the necessary law of torque control $M(t)$ and the angles of the hinges $\phi(t)$ as well as the force $\theta(t)$ as functions of time t . These problems are solved with the aid of an auxiliary model, namely a stiff one (both bars are stiff, but the hinges are as before). The algorithm of an analytical solution, which yields general expressions for the unknown variables, is illustratively applied to a manipulator movable in the three-dimensional space. Figures 7; references 10: 9 Russian, 1 Western.

[163-2415/12947]

TURBINE AND ENGINE DESIGN

UDC 621.512:629.12

COMPRESSOR WITH AXIALLY MOVING PISTONS AND ROCKING WASHER

Leningrad SUDOSTROYENIYE in Russian No 12, Dec 84 pp 19-21

BERSHADSKIY, S. A.

[Abstract] A compressor with a Girodin rocking washer and an array of axially moving pistons is considered as replacement of a horizontal compressor with a conventional slider-crank mechanism or other direct motion converting device. The washer is mounted on a spherical bearing at the end driven by a crankshaft and is coupled to at least three pistons symmetrically around its flange, to each of them through a connecting rod with one ball joint in the washer flangs and another ball joint in the piston head. As the washer is rocked by rotation of the crankshaft, some pistons slide forward and others slide backward in the horizontal cylinders. Two bevel pinions on both sides of the washer prevent its rotation. The kinematics and the dynamics of this mechanism are analyzed, taking into account the inertial gyroscopic moment of washer reaction on the shaft. A uniformly spaced circular array of sequentially moving pistons, as many as possible, ensures a uniform distribution of countertorque with a much smaller ripple factor than in a slider-crank mechanism. With axial motion of the pistons, vibrations of rotating components do not depend on the compressor runner speed. With small tilt angles of the connecting rods and with an untransposed normal force, the pistons move smoothly without appreciable impact against the walls of their cylinders. On the basis of these theoretical consideration, a Soviet prototype of such a compressor was built in an APK7.5 housing for a nominal suction capacity of $2.4 \text{ m}^3/\text{h}$ at 750 rpm. The unit was tested for 2000 h, driven by an a.c. electric motor. The amplitude of vibrations was 15-20 times smaller than in a comparable conventional compressor, power losses in the electric drive motor were 12-18% lower, and much less oil was needed for lubrication. It appears entirely feasible to design and produce such compressors for a life of up to 10,000 h. Figures 3; references: 2 Russian.

[179-2415/12947]

UDC 621.81:621.165

OPTIMIZATION OF BASING AND OF BASES ON ASSEMBLY UNITS AND TURBINE PARTS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 46-51

BEREZKIN, V. V., Engineer, and MIKHAEL, S. Yu., Engineer

[Abstract] Basing for turbine assembly is analyzed for accuracy of relative positioning of component parts, taking into account both static deflection of the runner and end play for its axial displacement during rotation. The stator, including bearing housings as well as seal retainers and diaphragm frames, must be aligned accordingly with the neutral axis of the runner. This is demonstrated on K-300-240 and K-800-240-3 steam turbines whose low-pressure, intermediate-pressure, and high-pressure cylinders must all be assembled within specific tolerances each. Particularly important are seals and thrust-bearing shoes. An analysis of blueprint dimensions indicates how the basing and the bases on assembly units can be optimized so as to minimize the number of parts affecting the necessary axial clearances and to allow for relaxing the tolerances. Figures 6.

[197-2415/12947]

UDC 629.12.03-815-531.6

RESPONSE SPEED OF GOVERNORS FOR REVERSIBLE SHIP TURBINE SETS

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 84 pp 26-28

GULYY, V. A.

[Abstract] Speed regulation of a reversible main ship turbine set is considered, such a set consisting of two steam turbines with gear coupling for forward and backward motion. The necessary response characteristics of a governor for this purpose is determined on the basis of turbine rotation dynamics. Calculations, in normalized quantities yield a linear relation between required ratio of governor response time (complete valve travel at maximum velocity) to total rotor acceleration time after load dumping and the maximum rotor speed after stepwise load drop under nominal operating conditions. For any such given maximum speed, moreover, this required time ratio depends linearly on the ratio of time during which the regulator valves of both turbines move simultaneously to time of complete valve travel at maximum velocity. The results indicate that speed regulation can be optimized without increasing the governor response speed, namely by optimizing the mode of valve travel so as to produce "countersteam" conditions as early as possible during reversal. Figures 2; references: 4 Russian.

[180-2415/12947]

UDC 621.313.13.025.045.2.001.24

MECHANICAL STATE OF CRYOMOTORS DURING TRANSIENTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 4, Jul-Aug 84 (manuscript received 23 Dec 82) pp 96-100

DANKO, V. G., YANTOVSKIY, L. I., MIROSHNICHENKO, A. G. and BERZIN, Ye. K.,
Kharkov

[Abstract] Transient currents during quenching of the magnetic field under fault conditions produce mechanical forces on the electromagnetic shield and on the frame of cryogenic d.c. motors. These factors are calculated here for such motors with superconducting field coils and separate cryostats around each pole. The calculations are based on the corresponding system of differential equations for the equivalent electric circuit, with each cryostat shell treated as a single-turn closed secondary winding inductively coupled to its field coil. This system of equations is solved, taking into account the temperature dependence of electrical resistances and, accordingly, their changes during the transient period. Numerical results have been obtained for a motor with an initial field current $I_f = 850$ A and a magnetic flux $\Phi = 1.65$ Wb in any one pole piece. These results include distributions of the shearing component and the normal component of electromagnetic forces. Both components are found to peak to dangerous levels, especially on the motor frame. The attendant Joule effect generates more heat and raises the temperatures to higher levels with the shield open than with the shield closed. All this must be taken into consideration in the design of cryostats for such machines.

Figures 5; references 3: 2 Russian, 1 Western.

[57-2415/12947]

UDC 621.313.322-813.013:527.312.62.001.24

HEAT TRANSFER IN ROTOR OF TURBOGENERATOR WITH SUPERCONDUCTOR WINDINGS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 4, Jul-Aug 84 (manuscript received 4 Jul 83) pp 101-106

GLEBOV, I. A., DANILEVICH, Ya. B., ZHURAVLEV, G. S., IVANOV, S. A., KARCHOV,
D. S., SOLOVEYCHIK, Yu. G. and SHURINA, E. P., Leningrad and Novosibirsk

[Abstract] The heat transfer in a turbogenerator with superconductor windings is analyzed numerically in three stages: 1) calculation of the temperature field in the idealized geometrical region for given conditions of cooling by liquid helium; 2) calculation of thermophysical and dynamic coolant characteristics at given temperature of heat exchanger walls; 3) coupling of rotor and coolant temperature fields with subsequent evaluation of the equilibrium state. Analysis and calculations are based on the corresponding system of Navier-Stokes and energy equations, including the thermodynamic properties of helium, which yield first-order partial differential equations of motion

with negligible pressure gradients, heat of friction, and Coriolis force. These equations are integrated numerically by combining the method of finite differences and the method of finite elements, nonlinearities being treated by successive iterations and appropriate boundary conditions being stipulated at the rotor entrance to the heat exchanger and at the heat exchanger walls. Data have been obtained on this basis for a KGT-20 MW turbogenerator. Figures 4; references 3: 2 Russian, 1 Western.

[57-2415/12947]

UDC 621.165.001.42

CLEARANCES AND VIBRATIONS OF RUNNER IN HIGH-PRESSURE CYLINDER OF T-250/300-240 TURBINE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 8, Aug 84 pp 44-47

PROKHOROV, S. A., Candidate of Technical Sciences, All-Union Institute of Heat Engineering, and ASTAKHOV, Yu. I., Engineer, TETs-22, Moscow Regional Administration of Power System Management

[Abstract] During operation of T-250/300-240 steam turbines there occur low-frequency vibrations of the runner in the high-pressure stage, these vibrations being produced by aerodynamic forces in statically and dynamically varying clearances. The characteristics and the causes of these clearance variations must be known for purposes of vibration control. An experimental study was therefore made using five Sybrook displacement transducers and a DVA-4 Sangamo Weston measuring system with thermocouples. Four transducers were placed in the radial clearance symmetrically around the runner circumference and one transducer was placed in the axial clearance. After calibration and taring of these transducers at six temperatures over the 25-500°C range, measurements were made during several successive and intermittent turbine start-run-stop cycles following a major overhaul. The data obtained in these tests have been analyzed so as to reveal the effects of load changes and temperature changes during both transient and steady-state periods of operation. Two recommendations with regard to maintaining nominal radial clearances in seals and thus reducing vibrations over long service periods are given on the basis of the results. The first one is that the turbine be assembled with the runner 0.4-0.5 mm off center in both vertical and transverse horizontal directions after overhaul so as not to let the minimum radial clearance in either direction decrease below 0.2 mm. The second is that the cylinder bearing seats be precooled for 2.5-3 h before kick-in of the runner for starting the turbine hot or semicold with steam up to 100°C hotter than the outside metal surface. Figures 6; references: 4 Russian.

[66-2415/12947]

OVERTLOAD TESTING OF 800 MW TURBOGENERATOR

Moscow ELEKTRICHESKIYE STANTSII in Russian No 8, Aug 84 pp 57-59

GONCHAR, V. F., Engineer, and GROKHOVSKIY, A. A., Engineer, Donbass Regional Administration of Power System Engineering Management

[Abstract] The feasibility of operating TVV-800 MW turbogenerators under 10% overload has been established theoretically but must be confirmed by tests. The purpose of preliminary tests performed at the Uglegorsk GRES with assistance from the Leningrad Economic Planning Department of "Elektrosila" was: 1) to determine on the basis of temperature rises the maximum permissible continuous turbogenerator power output with the coolant (hydrogen) pressure first raised up to 539 kPa and then dropped down to 392 kPa; 2) to determine the maximum permissible turbogenerator reactive power at a load power factor $\cos \phi = 0.85$ with the hydrogen pressure above nominal but the temperatures of hydrogen and water up to 8°C below nominal. The results of these tests were positive insofar as operation under nominal load (800 MW, $\cos \phi = 0.85$, 941 MVA) with 539 kPa hydrogen pressure and 5°C lower hydrogen and water temperatures, without deterioration of oil seals and leakage of hydrogen, or at 90% full load (720 MW, $\cos \phi = 0.9$, 800 MVA) with 392 kPa hydrogen pressure. Testing such a turbogenerator under 10% overload with nominal hydrogen pressure and under 90% full load with lower hydrogen pressure will require more thorough temperature measurements in the stator iron core and the winding end zones, with thermocouples installed in at least 100 points during assembly. Figures 3; tables 1.

[66-2415/12947]

TROUBLE SHOOTING OF GAS-TURBINE SETS WITH USE OF MATHEMATICAL LOGIC

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 84 (manuscript received 14 Jan 83) pp 107-109

FEL, Yu. I., Candidate of Technical Sciences, docent, and GALUSHKO, V. F., Candidate of Technical Sciences, docent, "Order of Labor's Red Banner" Krasnodar Polytechnic Institute

[Abstract] The statistical method based on Bayes likelihood estimators has been applied to trouble shooting of gas-turbine sets in service, for the purpose of preventive maintenance. The algorithm of diagnosis uses reliability data on individual vulnerable components in the turbine (blades, seals) as well as in the compressor (passages, blades, seals) and in the combustion chamber (fuel injection nozzles, flue duct). A binary state table is constructed with correspondingly a total of 10 variables, applicable to the two GTU-100 MW gas-turbine sets in the Krasnodar TETs (GTU-1 installed in

1970, GTU-2 installed in 1976). Assuming a technologically stable turbine operation, with a wear margin beyond the length of an operating cycle, failures due to excessive wear are regarded as ergodic random events. Data on failures of set components alone establish the confidence limits of the estimated rate and the accuracy of estimated probability of failure-free operation. A disjunctive logic algebra function is derived, with which the Bayes method with all the necessary apriori information yields, through algebraic operations, the probability of faults in components of such gas-turbine sets. Article was presented by Department of TES. Tables 2; references: 3 Russian. [119-2415/12947]

UDC 621.438

EXPERIMENTAL STUDY OF STARTING GAS-TURBINE ENGINE BY MEANS OF AIR SUPERCHARGE OR ELECTRIC STARTER

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 84 (manuscript received 6 Jul 83) pp 110-111

DAYNENKO, V. I., Candidate of Technical Sciences, docent, Sevastopol Institute of Instrument Design

[Abstract] An experimental study was made for the purpose of comparing two methods of starting a 750 kW gas-turbine engine, namely with an electric starter or with air supercharge. The electric starter was a standard d.c. motor for this application. Air supercharge was supplied by a diesel-driven centrifugal compressor feeding compressed air to the engine compressor. The engine starting speed-time and power-time characteristics as well as the temperature-pressure characteristic of the working medium and the current-voltage characteristic of the electric motor were recorded on oscillograms. The results indicate that, while starting with an electric motor is more economical, starting with air supercharge is more reliable without stiff mechanical coupling and is "softer" with the temperature before the turbine inlet dropping by 100-200°C. Air supercharge does not require engine design modifications. It is recommended for base starting or for standby. Figures 3; references: 5 Russian.

[119-2415/12947]

UDC 621.311-52:681.3

DESIGN OF PROTECTIVE AUTOMATION FOR POWER SYSTEMS ON BASIS OF CONTROL COMPUTERS

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 84 (manuscript received 5 Nov 83) pp 47-49

SENYAGIN, Yu. V., Candidate of Technical Sciences, and KIRPLYUK, M. R., Engineer, Institute of Power Engineering imeni G. M. Krzhizhanovskiy, Belorussian Branch

[Abstract] New methods of protective automation for power systems are being considered, with a control computer as the basis, because conventional relaying with contractor devices requires too much power, while stiff logic can sometimes produce redundancy or inadequate action and requires continual retuning. A decentralized structure of protective automation is preferable on account of high speed and high reliability, but is less selective and sometimes also less sensitive than a centralized one. Most promising appears to be an autonomously hierarchical distributed structure with systemwide station control as well as blockwise control. For purposes of protective automation, the behavior of each generator in a system is determined by its transient response characteristic and it becomes critical when an unbalance between turbine torque and electromagnetic torque results. Such an unbalance is best eliminated by changing the turbine power or the generator field excitation, or by adding a dummy resistance load. It is possible in each case to either return to the original state or proceed to any other state at any instant of time. These methods of correction help avoiding long shutdowns with attendant losses on restarting and resynchronization. A major problem in blockwise protective automation is measurement of the parameters which characterize the motion of the turbine runner, and here acceleration proportional to the torque unbalance rather than the torque unbalance itself can be used for determining the control action. Figures 1; references: 4 Russian.

[119-2415/12947]

UDC 621.438.056/438

ENERGY PERFORMANCE INDICATORS OF COMBUSTION CHAMBERS FOR AIRCRAFT ENGINE OPERATING WITH NATURAL GAS AS FUEL

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 84 (manuscript received 23 Aug 83) pp 72-77

KHRISTICH, V. A., Doctor of Technical Sciences, Professor, LYUBCHIK, G. N., Candidate of Technical Sciences, DIDENKO, V. I., Candidate of Technical Sciences, SHEVCHENKO, A. M., Candidate of Technical Sciences, and ILCHENKO, V. A., Engineer, "Order of Lenin" Kiev Polytechnic Institute imeni Semicentennial of Great Socialist October Revolution

[Abstract] General relations are established for the total power loss and its components in a combustion chamber for an aircraft gas-turbine engine. The

basic four components are loss due to incomplete combustion, loss due to nonuniform temperature field, losses due to hydraulic drag, and nozzle losses. Seven different combustion chambers are evaluated with respect to efficiency when operating with natural gas as fuel. They include four with ring construction (AI-20K, AI-24, AI-20D, NK-12MV) and three with tubular-ring construction (AM-3, RD-3M, D-25V), with four types of inlet device (perforated dish cone for AI-20K chamber; jet-flow turbulizer for AI-24 chamber; paddle wheel for AI-20D, NK-12MV, AM-3, RD-3M chambers, hemispherical slotted head for D-25V chamber). Also the dependence of power losses, chamber efficiency, and engine efficiency on the pressure rise during the engine cycle and on the velocity of the air stream has been determined in this way. The results indicate the optimum operating conditions for each chamber with natural gas as fuel, and that the optimum velocity of the gas stream is almost the same as that of the kerosene stream when they operate with liquid fuel. Article was presented by Department of Industrial Heat Power Equipment. Figures 3; tables 2; references: 6 Russian.

[119-2415/12947]

UDC 621.438.004

MODELING DISPERSION OF MARINE AEROSOL FOR STUDY OF SHIPBOARD GAS-TURBINE SETS

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 84 (manuscript received 19 May 83) pp 77-81

LASTOVTSOV, A. Yu., Candidate of Technical Sciences, and ROSLIK, Ya. F., Candidate of Technical Sciences, "Order of October Revolution" Leningrad Higher Marine Engineering Academy imeni S. O. Makarov

[Abstract] An aerosol generator has been built for simulating marine aerosol, its dispersion and the kinetics of its fractions. The performance of this generator is based on the theory of particle sedimentation in air and its design is based on mathematical relations for sea air. The generator, which produces an aerosol model in the laboratory, consists of an atomization chamber with a blower inside underneath a well into which air is blown upward. The well widens uniformly from bottom to top, between two vertical flow straightening grids. An ejector nozzle at the blower level feeds compressed air under a pressure of 0.2 MPa into the atomization chamber through one tube and feeds water through another tube, by suction, into the same chamber. The size distribution of particles at various velocities of the ascending air stream and the dependence of the largest size on that velocity were determined experimentally with this generator, for verification of theoretical data pertaining to the design of shipboard gas-turbine sets and air filters subject to surface salination. The results indicate that, as the air velocity increases to 0.5 m/s and beyond, the aerosol size spectrum widens with an attendant lowering of the peak and shifting of the latter toward finer fractions. The radius of the largest particles, measured in a special experiment, was found to fit the empirical relation $r_{\text{max}} = -220V^2 + 217V + 7.95$ um (V , m/s - velocity of ascending air stream). Figures 3; references: 5 Russian.

[119-2415/12947]

AERODYNAMIC OPTIMIZATION OF DIFFUSER IN GAS TURBINE

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 84 (manuscript received 13 May 83) pp 81-87

GOGOLEV, I. G., Candidate of Technical Sciences, docent, KUZMICHEV, R. V., Candidate of Technical Sciences, docent, DROKONOV, A. M., Candidate of Technical Sciences, docent, ZAIKIN, I. D., Candidate of Technical Sciences, docent, and KOCHEGAROV, A. A., Engineer, "Badge of Honor" Bryansk Institute of Transportation Machinery Building

[Abstract] In gas turbines with split shaft a usually straight slightly diverging diffuser with a long strut inside, between high-pressure stage and low-pressure stage, ensures smooth transfer of the working medium with minimum losses. Two models of such a diffuser were built and tested in an aerodynamic optimization study. One model had the outer tube wall specially profiled according to recommendations by the "Turbomotor Plant" Industrial Association. The second model included control of the boundary layer, specifically its recirculation from the high-pressure zone to the low-pressure zone. Measurements were made in a static test stand with pneumometers probing the cross section at various location along the diffuser. Determined was also the dependence of the diffuser efficiency on the orientation of a strut relative to the direction of flow. Recommendations for aerodynamic optimization of such diffusers are: stepping the outer diffuser wall on the entrance side, maximizing the distance from strut edges to diffuser exit section, with appropriate meridional profiling of the outer tube wall around a strut, incorporating control of the boundary layer, and shaping the strut for shockless streamlining during nominal operation of the preceding stage. Article was presented by Department of Turbine Construction. Figures 3; tables 1; references: 4 Russian.

[119-2415/12947]

NAVIGATION AND GUIDANCE SYSTEMS

UDC 629.124.68.073.243.001.24

CONSIDERATION OF ROCKING IN DESIGN OF SHIPS FOR SATELLITE COMMUNICATION SERVICE

Leningrad SUDOSTROYENIYE in Russian No 11, Nov 84 pp 3-4

KUZMENKO, A. V. and RYAZANTSEV, Yu. I.

[Abstract] The design of ships for satellite communication service is considered, a major problem being stability of antenna performance on rough sea. Semiempirical approximate relations between characteristic ship dimensions, mean amplitude of ship rocking, and sea roughness parameters have been established which simplify initial design estimates for reliable communication service. These relations are based on the Hovgaard formula and a Rayleigh distribution of ship movements. Graphs of these relations further facilitate calculations, a precise analysis based on ship and communication theory being much too unwieldy here. Figures 3; tables 1; references: 6 Russian.

[121-2415/12947]

UDC 621.313

FORCE CHARACTERISTICS OF ACTIVE MAGNETIC SUSPENSION

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 21 Nov 83) pp 57-63

LYSENKO, A. P., OBRAZTSOV, A. N. and TORAMANYAN, O. S., Leningrad Institute of Mechanics

[Abstract] An active magnetic suspension is considered which consists of two vertical wound four-pole support stators with conical bore surfaces facing each other. They act as electromagnetic bearings for rotors on both ends of a horizontal shaft carrying the payload at the center. Since the air gaps between each rotor and its bearing stator are inclined, there are a horizontal (axial) z-component and a vertical (radial) y-component of rotor pull toward the stator. The resultant centering force on the rotor pair by both stators is calculated from the currents in the windings around poles and the

magnetic reluctances of the structure, iron parts as well as air gaps. On this basis is designed a control amplifier-converter for regulation of the force-displacement characteristic, $F(z)$ in the axial channel first, by ensuring a current variation $I_L = I_0(1+kz)$ in the left-hand stator and $I_R = I_0(1-kz)$ in the right-hand stator (k - amplifier gain). The regulator parameters will depend on the starting characteristics of the suspension. With axial centering established, radial centering is analyzed for complete design and performance evaluation. Article was recommended by Department of Electrical Engineering. Figures 4; references: 4 Russian.
[127-2415/12947]

UDC 681.3

CALCULATOR OF VECTOR MODULUS FROM TWO ORTHOGONAL COMPONENTS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 21 Sep 83) pp 27-31

KOVALEV, A. M., PUCHKOV, Yu. I. and PERELYAYEV, V. Ye., Moscow Institute of Power Engineering, Smolensk branch

[Abstract] A calculator of the vector modulus is described which performs the two mutually inverse operations of squaring and square-root extraction on two orthogonal vector components. High accuracy is ensured by the same calculator components performing both operations. In the fundamental concept such a calculator consists of an integrator which, triggered by control signals, generates a sawtooth voltage $V_s(t) = K_1 E_1 t$ (t - time, K - slope), a second integrator which upon triggering generates a voltage $V_{i2} = V_1^2 K_2 / K_1 E_1$, a third integrator behind a 2-position switch which generates a constant output voltage $V_0 = \sqrt{V_1^2 + V_2^2}$ (V_1, V_2 - orthogonal input voltages), a comparator with input voltage V_1 for the first integrator, two 3-position switches on the input side, and an inverter between the output of the third integrator and one of the three contactors of the 3-position switch for the second integrator on the input side, with the output of the third integrator connected to the third contactor of the other 3-position switch for the comparator on the input side directly. The two 3-position switches, mechanically ganged and simultaneously actuated by the same control signals as both first and second integrators, trigger the operation of both and of the comparator so as to let $V_s(t_1) = V_1$ and $V_s(t_2) = V_2$. The comparator serves also as error corrector ensuring that $\Delta V = (V_1^2 + V_2^2 - V_0^2) K_2 / K_1 E_1 = 0$. In the practical version both 3-position switches and the inverter are omitted, and the third integrator is replaced by an adder which generates the same output voltage with the aid of a controlled external storage. The calculator circuit can be connected for operation in single stroke or in push-pull, the former operation being faster. A calculator built for this operation was tested at the Department of Automation and Remote Control, its error not exceeding 0.3% over the 0-40°C temperature range at an operating speed of 1 ms. Article was

recommended by Department of Automation and Remote Control. Figures 4;
references 5: 4 Russian, 1 Western (in Russian translation).
[127-2415/12947]

UDC 621.396.932.1

COMPENSATION OF INSTRUMENT ERROR IN ACOUSTIC ANGLE MEASURING SYSTEM BY
MEANS OF TEST SIGNAL

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in
Russian Vol 27, No 12, Dec 84 (manuscript received 13 Dec 83) pp 7-10

NAUMENKO, I. Ya. and SKRIPCHENKO, S. V., Kiev Polytechnical Institute

[Abstract] A method is proposed for correcting measurement of the parameters of the information signal in acoustic angle measuring systems by comparing them with measurements of analogous parameters of a test signal. The problem of selecting the time offset between the information and test signals as a function of the parameters of the fluctuations in the channels and the required depth of correction of the errors they cause is investigated for a two-channel phase angle measuring system. It is found that the time offset between the information and test signals must be set so that the normalized correlation function of the fluctuations in the phase-frequency characteristics of the channels measured for the same time offset exceeds 0.5. The method was tested experimentally on a Tembr-2m two-channel angle measuring system. References: 4 Russian.

[140-6900/12947]

UDC 531.38

DYNAMICS OF ROTATION OF CONTACTLESS GYROSCOPE DURING RANDOM VIBRATION OF
PLATFORM

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA MEKHANIKA
in Russian No 1, Jan-Feb 85 (manuscript received 16 May 83) pp 70-74

MEDVEDEV, A. V.

[Abstract] Rotation of a contactless gyroscope during random vibration of the platform is analyzed, assuming that the force field stabilizes the position of gimbals relative to the movable platform but has no significant influence on the small angular displacements of the wheel relative to the suspension center. The problem is equivalent to motion of a solid body relative to one point which moves together with the base. A further assumption is made that the principal ellipsoid of inertia with respect to the suspension center is an ellipsoid of revolution, while the suspension center moves according to a random law along a stationary straight line without gravitation.

Angular displacements of the gyroscope are calculated upon introduction of four regular orthogonal trihedra: the first one stationary, the second one serving as reference system for angular displacements with axes remaining parallel to the corresponding axes of the first one, the third one tied to the angular momentum vector, the fourth one tied rigidly to the moving body, and all except the first one having a common origin at the suspension center. The system of differential equations describing the angular motion of the gyroscope relative to the suspension center consists of three equations of moments with the proportionality factor ϵ as small parameter and three equations of osculation. After reduction to dimensionless form, with the nutation period as time scale, this system is solved asymptotically by reference to free motion of a symmetric body when $\epsilon = 0$ and introduction of appropriate new variables which are functions of time for perturbed motion when $\epsilon \neq 0$. The solution to this thus modified system of equations describes a random vector process and is sought in the approximation of a random Markov process, smooth in space and bounded in time. Accordingly, the process correlation time is assumed to be much shorter than the process relaxation time $T = \epsilon^2$.

References: 7 Russian.

[164-2415/12947]

UDC 531.1

EFFECT OF SELF-MODULATION ON NUTATION OF CONTACTLESS GYROSCOPE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 5, May 84 (manuscript received 23 Jun 82) pp 104-109

KOMAROV, V. N., Scientific Research Institute of Applied Mathematics and Cybernetics, Gorkiy State University

[Abstract] Rotation of a balanced gyro wheel in an axisymmetric electric or magnetic field of its contactless suspension is analyzed, assuming that the ellipsoid of rotation coincides with the ellipsoid of inertia and the angular velocity vector lies on or negligibly deviates from the axis of dynamic symmetry. For a rotor spinning fast about a stationary point, with two of the Euler angles remaining small, normalization of the two corresponding Euler equations reduces them to two equations of nutation with respect to the third Euler angle and the nutation time scale. In this case $M_0 \ll H_0 \Omega_N$ (H_0 - axial component of angular momentum, M_0 - external moment, Ω_N - nutation speed of dynamic rotor axis about angular momentum vector) and the solution of these equations for ideal $\mu = M_0/H_0 \Omega_N = 0$ describes the free motion of a rotor fixed at one point. Considering that the principal drift causing moment results from interaction of the gyro wheel and the electric or magnetic suspending field when the wheel surface is nonideal because of manufacturing imprecision and usually has its own differently oriented axial symmetry, this drifting moment is evaluated here in terms of Legendre polynomials. When the suspending field is automatically controlled, with transducers ideally insensitive to rotation of the gyro wheel, such an axisymmetric manufacturing imprecision causes fluctuation of the transducer signal and consequently modulation of

the suspending field. A moment will thus be produced which can destabilize the nutation of the gyro wheel. This is demonstrated analytically on the simplest gyroscope with a ferrite wheel suspended by the field of two coaxial electromagnets, stability along the axis of symmetry of the suspension being ensured by an automatic control system and stability across that axis being ensured by the field configuration. Experimental data confirm the possibility of nutational instability caused by such a self-modulation, also the feasibility of attenuating nutational flutter with the aid of narrow-band filters rather than additional dampers. References 12: 11 Russian, 1 Western (in Russian translation).

[124-2415/12947]

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

UDC 681.586:681.2

DEPENDENCE OF ACCURACY OF ANGLE-TO-TIME CONVERSION ON INCLINATION OF SCAN PLANE

Moscow METROLOGIYA in Russian No 10, Oct 84 pp 32-36

BOGATYRENKO, K. I.

[Abstract] An angle transducer with conversion of angle to time interval is considered which consists of two photoreceivers and a scanner carrying a directional light source such as a laser with focusing optics. The photoreceivers have each a slit oriented perpendicularly to some base plane. On the basis of conventional coordinate transformations and the relation for the angular velocity of a vector projection, the degree of conversion linearity is found to depend on the inclination of the plane of the scanning beam relative to that base plane. Even when the mirror rotates ideally at a constant velocity, the compensating quantity will have a component whose frequency is twice the scan frequency and whose phase depends on the direction of the slope. The error of angle measurement caused by nonlinearity of the scan depends on the measured angle and on the initial phase, being largest at angles near $\frac{1}{2}\pi$ or $\frac{3}{2}\pi$ when the initial phase is zero and reaching magnitudes near the inclination angle squared. The variation of the compensating quantity can be determined accordingly and the necessary angle correction introduced for attainment of a given measurement accuracy. The same principle of analysis is applicable to passive converters with a scanning photoreceiver for measuring the angle between two light beams. References: 4 Russian.
[117-2415/12947]

UDC 621.397.331

OPTOELECTRONIC SCANNERS FOR IMAGE PROCESSING WITH SEQUENTIAL-PARALLEL PROCESSOR

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 21 Feb 83) pp 69-77

GORELIK, S. L., Leningrad Institute of Precision Mechanics and Optics

[Abstract] New optoelectronic image processors are now built on the most advanced technological base, their principal feature being the use of an

electrically controllable optical aperture for scanning the plane of an image recorded on a photographic carrier. The luminous flux leaving the aperture is modulated in conformance with the transparency distribution over the image plane and then converted into an electric signal equivalent to the corresponding surface integral. The weight function of the linear space filter, determined by that aperture as function of the two coordinates in the image plane and of the controllable aperture parameters, is usually one with sign reversal and the filter can be made either space-dependent with the aperture parameters varied along the space coordinates or brightness-dependent with the aperture brightness varied depending on the mean signal level within its vicinity. Any algorithm of image processing yields filter responses at each point of the image field, assuming that the parameters of the image object are apriori known and the parameters of the filter are established by the conditions of the particular processing problem. Typical three such algorithms are extraction of contour elements with given orientation by means of an anisotropic filter, filtration of fine-structure interference or noise, and correction of visual contrast. A locally adaptive anisotropic filter is considered for optimal extraction of image contours, such a filter belonging in the class of sequential-parallel ones. It can be built with optico-mechanical, optoelectronic, or cathode-ray devices, including either digital or analog electronic scan control in each case. Optoelectronic synthesis of a controllable optical aperture, based on luminescence under electron-beam bombardment and using controllable function converters or interchangeable sets of different transform modules, is preferable because of its high speed and reliability. In addition, shape converters are often required for correcting image distortions during processing. Simultaneous shape conversion and scanning is an important advantage of such a processor, more difficult to achieve with digital devices because of the discrete signal structure. It is furthermore feasible to process live scenes transmitted through television cameras with controllable aperture and cathode-ray "light to electric signal" converters with storage. This requires special cathode-ray tubes with restorable target. A special algorithm has already been developed for this purpose, synthesizing a space-dependent locally adaptive filter for sequential-parallel convolution. The entire processor system includes also a comparator followed by a memory, both feeding back to the television camera through a control module. Figures 5; references: 8 Russian.

[127-2415/12947]

UDC 535.317.2

ERRORS OF OPTOELECTRONIC SCANNERS FOR MEASUREMENT OF COORDINATES OF MOVING RADIATING OBJECT

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 2 Jan 83) pp 77-81

SHIRABAKINA, T. A., Moscow Institute of Geodetical, Aerial Photography and Cartographical Engineers

[Abstract] An optoelectronic scanner is considered for measuring the coordinates of radiating objects in motion. A vertically oriented linear multi-element photoreceiver scans the field of action horizontally at a constant speed. An error analysis of this device includes errors caused by a variance of photoreceiver parameters and by instability of the scanning speed. These errors are estimated here, assuming a photoreceiver output signal proportional to the incident radiant flux from the target and to the volts per watt sensitivity of the photoreceiver. With the incident radiant flux expressed as the product of detecting power and signal-to-noise ratio, both the photoreceiver bandwidth and sensor surface area are expressed through the scan parameters so that the maximum absolute measurement error can be calculated as a function of both photoreceiver and scan parameters. The relations simplify in the case of square photoreceiver elements. Such an analysis, involving a function of several variables, has been programmed for a YeS-1022 digital computer. Article was recommended by Department of Optoelectronic Devices. Figures 3; references: 4 Russian.

[127-2415/12947]

UDC 535.8

CALCULATION OF ILLUMINANCE DURING COHERENT COMPREHENSIVE ILLUMINATION WITHIN APERTURE

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 24 Mar 84) pp 62-66

LAZAREVA, G. V. and NATAROVSKIY, S. N., Leningrad of Precision Mechanics and Optics

[Abstract] A method is described for calculating the illuminance of an object employing a laser in combination with a lens raster as a light source, with optical energy arriving at each point of the illuminated object from each lens element of the raster. A formula for the illuminance is derived that assumes a Gaussian distribution of the amplitude field over the cross section of a laser beam. The present results make it possible to refine a formula derived elsewhere; the proposed formula is found to yield highly accurate results. References: 6 Russian.

[140-6900/12947]

UDC 621.752

ENERGY ANALYSIS OF DARK-FIELD AUTOREFLECTOR

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 5 May 84) pp 66-70

MIKHEYENKO, L. A., MELNIK, I. S. and KOLESNIK, I. V., Kiev Polytechnical Institute

[Abstract] The problem of ensuring minimum energy losses with severe size restrictions in dark-field optical systems employed in optoelectronic devices that operate on the basis of fluctuations in the radiant flux reflected from a rough surface. The coefficient of utilization of the radiant flux is determined for different apertures of the illuminating and receiving channels of a lens autoreflector. It is found that increasing the aperture of the receiving channel beyond 10 - 15 degrees is inadvisable, inasmuch as a relatively small increase in the coefficient of utilization results in a substantial increase in the size of the autoreflector. Vignetting of the receiving channel reduces the coefficient of utilization of the incident flux, with the greatest energy losses occurring in a narrow zone close to the illumination channel. The most effective method for increasing the coefficient of utilization is to reduce the aperture of the illumination channel, which also reduces energy losses in the non-working zone. References: 4 Russian. [140-6900/12947]

UDC 681.7.069

MOIRE OTOELECTRONIC DISPLACEMENT METER

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 29 Dec 84) pp 70-72

GORODETSKIY, A. Ye., KUZMIN, P. P., PANKOV, E. D. and FEDUKOVA, N. A., Leningrad Institute of Precision Mechanics and Optics

[Abstract] An optoelectronic displacement measuring system that works by counting the number of Moire bands passing through a photodetector is described in which the loss of bands that can reduce measurement accuracy significantly is prevented by forming a Moire pattern with variable band spacing when the rasters are combined in the plane of the photodetectors, and having each photodetector receive the image of a specified band. Good agreement is found between the experimental and analytical data. References 4: 3 Russian, 1 Western. [140-6900/12947]

UDC 535.31

REFLECTORS IN FORM OF MIRROR-SYMMETRICAL ANGLES

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 15 Feb 84) pp 53-57

PROTSKO, S. V. and KHAPALYUK, A. P., Scientific Research Institute for Applied Physics Problems imeni E. N. Sevchenko, Belorussian State University imeni V. I. Lenin

[Abstract] New systems of mirrors are investigated that provide reflecting properties similar to those on an ordinary flat or dual rectangular mirror; the latter represent the two basic classes into which the systems of mirrors fall, regardless of the way in which the initial incident beam propagates. The reflectors in each class are characterized by common reflecting properties, and differ with respect to others (e.g., polarization). References: 8 Russian.

[140-6900/12947]

UDC 62.531

ALLOWANCE FOR PERTURBATIONS IN SYNTHESIS OF PRECISION AUTOMATIC SYSTEMS FOR TAPE TRANSPORT MECHANISMS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 12, Dec 84 (manuscript received 27 Sep 84) pp 15-22

STRYUCHENKO, A. A., Kiev Polytechnical Institute

[Abstract] An approach to the synthesis of automatic tape transport mechanisms based on the theory of random processes is proposed in which the mean square deviation of the output coordinate is reduced. An electromechanical assembly incorporating an amplifier, a take-up motor, a transport mechanism and drive shaft is investigated. The perturbations are assumed to be oscillations in the gain of the amplifier, the torque of the motor and the transfer coefficient of the mechanism connecting the motor to the drive shaft, as well as eccentricity of the drive shaft. Correlation and spectral density curves are obtained by computer for the oscillations in the speed of the motor and irregularity in the rotation of the drive shaft. A precision automatic tape transport system is synthesized in accordance with proposed method as an example. The closeness of the desired and actual transfer functions confirm that the proposed method is correct. References 5: 4 Russian, 1 Western.

[140-6900/12947]

PERFORMANCE OF RING LASER WITH RANDOM FREQUENCY OFFSET

Moscow RADIOTEKHNika I ELEKTRONIKA in Russian Vol 29, No 10, Oct 84
 (manuscript received 21 Apr 83) pp 1971-1976

SVIRIDOV, M. V.

[Abstract] A sign-reversing frequency offset (switching frequency ν) with a random component is considered for a ring laser in angular velocity or displacement measuring instruments, the purpose being to suppress the adverse effect of interaction of oppositely traveling waves on the measurement accuracy. The integral of the frequency offset, i. e., the phase offset is calculated as function of that random component, assuming the latter to be a stationary wideband random process. Then the error of angular displacement measurement can be approximated as a random function with noncorrelated increments and with known drift and diffusion coefficients. Calculations are based on the phase equation for a ring laser, assuming diffusion only and a phase offset P which varies harmonically in time with an amplitude $\lambda \gg 2\pi$ when its random argument ξ with a characteristic correlation time t_0 is zero. After the small parameter $\epsilon \sim \Omega_0/\nu\sqrt{\lambda} \ll 1$ ($2\Omega_0$ - width of locking band) has been introduced, asymptotic integration is performed by the method of averaging with an accuracy of first order in that small parameter. The result yields a simple model of measurement error. This is demonstrated on phase offsets $P(\nu t, \xi) = \lambda \sin \nu t + \xi$ (ξ - normal process with zero mean and dispersion σ^2) with a correlation function $R(t) = \sigma^2 e^{-t/t_0}$ for ξ , and $P(\nu t, \xi) = \lambda \sin(\nu t + \xi)$ (ξ - stationary Markov process with uniform distribution over interval $[-\pi, \pi]$ and a two-dimensional distribution function $W(\xi_1, \xi_2)$ corresponding to phase diffusion). In both cases there is a zone of laser sensitivity to its rotation, with the steady-state diffusion coefficient independent of the rotational speed ω . In the first case the expression is the same for the diffusion coefficient outside and inside the parametric locking band, when $\omega = m\nu$ (m - integer). In the second case the diffusion coefficient peaks sharply at $\omega = m\nu$ far from the parametric locking band when the phase offset is a narrow-band one. References 9: 8 Russian, 1 Western (in Russian translation).

[36-2415/12947]

FLUID MECHANICS

UDC 621.839.001.24

FRictional characteristics of varidrive with separate cones and self-tightening ring

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 13-16

ROMASHKIN, O. G., Candidate of Technical Sciences

[Abstract] The performance of varidrives with separable cones and self-tightening ring, simplest and most compact of all variable-speed transmissions, is analyzed with emphasis on friction as the determining factor. The object is to establish the necessary clearance setting, which depends on the ring deflection under load and determines the cone-ring fit. Numerical data have been obtained for a varidrive whose both driver and follower cones as well as self-tightening ring are made of ShCr15 steel with surface hardness HRC 61-65 and surface roughness $R_o = 0.32-0.63 \mu m$ in the contact zones. The dependence of the friction coefficient, the contact pressures, and the average peripheral velocities on the output torque has then been evaluated by curve fitting of experimental data. Experiments were performed with the varidrive regulating the speed of a 370 W - 1410 rpm electric induction motor with speed reducer gearing over a 2.7:1 range, below its 10.75:1 capacity, in separate tests with three different lubricants: 1) 25% MS-20 + 75% MK-8 naphthene-paraffin base, kinematic viscosity $\nu_{50} = 15 \cdot 10^{-6} m^2/s$; 2) IPM-10 synthetic isoparaffin base with antiwear, anti-oxidation, and other additives, kinematic viscosity $\nu_{50} = 9 \cdot 10^{-6} m^2/s$; 3) "longlife" Heynau-Oil carbon grease, kinematic viscosity $\nu_{50} = 16.6 \cdot 10^{-6} m^2/s$. The results reveal that, unexpectedly, in this application the IPM-10 lubricant has better frictional characteristics than the MS-20 + KM-8 mixture, while the increase of shear stress lags behind an increase of contact pressure least in Heynau-Oil grease. Figures 4; tables 1; references: 7 Russian.

[197-2415/12947]

UDC 621.757.007.52

ROBOTIZED ASSEMBLING EQUIPMENT WITH MULTIBASE PLANETS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 62-64

VERTOGRADOV, O. N., Candidate of Technical Sciences

[Abstract] Robotization of multipositional assembling equipment is considered, such equipment being now built with single-base or single-unit planets. The possibility of designing and using multibase planets is examined from the standpoint of more effective automation, applicable specifically to equipment which includes an automatic manipulator with positioning and orientating devices as well as assembly head and conveyor. The analysis breaks down into schematic representation of an assembly process, generally based on parallel-sequential technology, and binary classification with corresponding codification of planets. Robotized assembling equipment is designated as RAEn, where n denotes the number of classification criteria. Five most important criteria are: 1) number of bases on one planet (one-many); 2) form of bases on one planet (same-different); 3) arrangement of bases on one planet (separate-overlapping); 4) geometry of bases (fixed-variable); 5) possibility of relative shifting of bases on one planet (yes-no). Qualitative analysis in general and schematic terms must be followed by quantitative evaluation and statistical analysis for optimization of the number of bases per planet, on which productivity and flexibility as well as reliability and accuracy of robotized assembling equipment depend. Figures 5; references: 7 Russian.

[197-2415/12947]

UDC 621.891

LUBRICATION BY PLASTIC LUBRICANT DURING ROLLING WITH SLIDING UNDER HEAVY LOAD

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 27-30

DROZDOV, Yu. N., Doctor of Technical Sciences, SHIROBOKOV, V. V., Candidate of Technical Sciences, and PASHKOV, A. I., Engineer

[Abstract] The behavior of a plastic lubricant such as grease in elastohydrodynamic contact between bodies rolling with sliding under load is analyzed theoretically, considering that the viscosity of the material decreases with increasing rate of shear strain until it levels at a constant low value as the strain rate becomes very high. In the rheological model the shear stress is equal to the yield point plus two terms, one becoming dominant at low strain rates and one becoming dominant at high strain rates. This model is applied to a lubricant film between two deformable metal cylinders rolling with sliding. The corresponding equations of lubrication theory are solved by the Hertel-Grubin method for the film thickness. The solution is evaluated for six different lubricants consisting of a grease base (alkali naphthalin, isoparaffin, mineral grease, mineral grease + ester mixture) with soap

(sodium, lithium, lithium stearate, sodium complex) as thickener. Experimental data have been obtained by the electrical method of sending a weak current not larger than 20 μm through the roller-grease-roller system. The combination of theoretical and experimental data yields the dependence of lubricant film thickness on rolling velocity and sliding velocity, both velocities lumped into an effective rolling velocity, a semiempirical relation for the friction coefficient as function of two surface parameters, Brinell hardness and roughness, and the dependence of a contact index (0-100%) which characterizes the lubricant performance within the friction zone under load on the effective rolling velocity. Figures 3; tables 1; references 6: 4 Russian, 2 Western.

[197-2415/12947]

UDC 621.891-762.001.4

EVALUATION OF LOAD CAPACITY OF COATINGS BY METHOD OF CROSSED CYLINDERS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 31-33

SEMENOV, A. P., Doctor of Technical Sciences, SOROKKO, A. A., Engineer, KATSURA, A. A., Candidate of Technical Sciences, and VORONIN, N. A., Candidate of Technical Sciences

[Abstract] A quick rough method is proposed for experimentally evaluating the load capacity of antifrictional coatings on bodies in kinematic contact, such coatings being most effectively deposited by an ion-plasma process. A high load concentration is produced by pressing a long cylinder between two parallel short coated cylindrical specimens perpendicularly to them and then rolling, without or with sliding, those two short cylinders together over that long one. As the two cylinders roll, their motion consisting of simultaneous rotation and translation with the peripheral velocity of the former equal to half the velocity of the latter, the pressure force will increase linearly. The friction force is measured in a dynamometer with exchangeable flat springs and recorded with an electronic strain gauge. The method tested on a long cylinder of nitrided 38CrMo-YuA alloy steel with HRC 58-60 surface hardness and two short cylinders of 45 carbon steel with HRC 22-24 surface hardness. The short cylinders had been ground and polished to a surface roughness $Ro = 0.04-0.08 \mu\text{m}$, then coated with 4-25 μm thick TaN films of $H_{50} = 220-250 \text{ MPa}$ microhardness by reactive electron-plasma spray. One outstanding advantage of this method is that random local defects in the coating leave the contact zone without having caused avalanche breakdown of the film so that their effect on the test results is almost negligible. It is thus possible to reliably determine the dependence of the critical load and of the friction coefficient on the coating film thickness. Figures 4; references: 3 Russian.

[197-2415/12947]

UDC 621.839:621.893-982

EFFECT OF RUN-IN ON LIFE OF ANTIFRICTIONAL SOLID LUBRICANT COATINGS IN VACUUM

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 33-35

GAMULYA, G. D., Engineer, OSTROVSKAYA, Ye. L., Candidate of Technical Sciences, and YAROSH, V. M., Engineer

[Abstract] A study of antifictional solid lubricant coatings in air and in vacuum has been made, for the purpose of determining their load capacity and life after run-in. Experimental data were obtained with an initially 20 μm thick film of VNII NP-212 solid lubricant containing an antifictional ingredient and MoS_2 , on a disk of normalized 45 carbon steel 70 mm in diameter rolling against a ball of ShCr15 alloy steel 10 mm in diameter at a peripheral velocity of 0.8 m/s in a special UTI friction and wear testing apparatus with vacuumization facility. Measurements were made under a normal load of 20 N and 50 N after run-in under ambient pressures of 10^5 Pa and 10^{-5} Pa respectively. The run-in was done under a stepwise increasing load, beginning with 10 N and following with increases in 10 N steps after the friction force had stabilized each time. The data have been evaluated analytically, with the ratio of and the difference between maximum run-in load and critical seizure load as performance criteria. The results indicate that run-in with stepwise load increases in air or in vacuum raises the load capacity and lengthens the life, by reducing the wear, of the solid lubricant coating. The effectiveness of such a run-in depends essentially on the temperature in the contact zone and the mode of heat transfer. Air is found to reduce the effectiveness, because of its cooling effect with attendant buildup of lubricant adsorption layers and decreased mobility of the antifictional particles as well as abrasive action of the MoS_2 particles. Accordingly, run-in vacuum is preferable and the loading scheme can be optimized for maximum effectiveness. Figures 4; references: 3 Russian.

[197-2415/12947]

UDC 621.893:620.193.24

EFFECT OF GASEOUS CARBON DIOXIDE ON ANTIFRICTIONAL CHARACTERISTICS OF SOLID LUBRICANT COATINGS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 35-37

MATVEYEVSKIY, R. M., Doctor of Technical Sciences, LAZOVSKAYA, O. V., Candidate of Technical Sciences, and POPOV, S. A., Engineer

[Abstract] A study of four solid lubricant coating materials in an atmosphere of dry CO_2 has been made, for the purpose of determining the effect of this gas on their heat resistance and wear resistance during friction. Three of them were MoS_2 -base VNII NP-212 (with urea-formaldehyde resin), NP-230 (with epoxy resin), NP-250 (with silicone resin), one was graphite-base VNII NP-251

(with polyamide resin). They were tested on disks rolling against a ball of 9Cr18Sh alloy steel at a peripheral velocity of 0.13 m/s while rotating at a speed of 52 rpm, with the contact zone under a load of 5.1 N in CO₂ under a pressure of 0.105 MPa and, for control measurements, also in atmospheric air. During short (1 min) test runs the temperature was increased in 10-20°C steps from 25°C to 700°C. During long (10 h) test runs the temperature was held at 250°C, and then at 350°C till complete wear-down of the coating. The results indicate that both the friction coefficient and the wear rate of all three MoS₂-base lubricants are at each temperature level lower in CO₂ than in air, the VNII NP-250 formulation having the best characteristics, while the friction coefficient and the wear rate of the graphite-base lubricant are slightly lower in air. The optimum operating temperature, in air or in CO₂, is 150°C for all four lubricants: with minimum wear and no tear of the coating found after 31.10³ cycles. Figures 2; tables 5; references: 4 Russian. [197-2415/12947]

UDC 621.893.002.237

OPTIMIZATION OF CONTENTS OF POLYMER-MINERAL COMPOSITE COATING MATERIAL

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 38-40

ZOLOTAR, A. I., Candidate of Technical Sciences, LEONIDOV, L. D., Candidate of Technical Sciences, and SHEYVEKHMAN, A. O., Engineer

[Abstract] The content of a coating material with polymer base and mineral filler, used for protection of cast iron in hydraulic machinery against erosive and abrasive wear, can be optimized for its maximum wear resistance. The theoretical analysis of this problem is based on an equation for fatigue wear in a stream of solid particles, considering only the friction component and disregarding the impact component in a typical device such as a sump pump. This component ϵ of strain, characterizing the wear, is related to the stress amplitude σ according to the semiempirical power law $\epsilon = K\sigma^m$ according to the mechanism of elastic dislodgement. Centrifugal forces acting on the surface layer of the rotating machine part as well as interaction of its rough surface with an impacting solid particle of random irregular shape during contact and subsequent penetration are taken into account by combining the applicable equation of motion with Hertz's law for quasi-static collision. The resulting dependence of strain and wear ϵ on the grain size R_0 (equivalent grain radius) is described by the function $\epsilon = K(c_1 R_0 + c_2 R_0^{-2})^m$, which has a minimum. The radius $R_{0,m}$ corresponding to that minimum is the optimum radius of solid particles for minimum wear of the coating. Numerical data based on this theory have been obtained for a coating with phenol-formaldehyde base and electrocorundum filler, to protect the runner of a 5GrK-8 pump in water which carries sand of the 2R 0.5 fraction. The optimum grain size of the mineral filler for typical operating conditions is found to be $2R_0 = 4.86$ mm. Figures 1; references 6: 5 Russian, 1 Western (in Russian translation). [197-2415/12947]

UDC 621.891.001.4

OPTIMIZATION OF MATERIALS FOR HEAVY-DUTY METAL-OIL-METAL COUPLES ON BASIS OF LABORATORY TEST DATA

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 24-27

MATVEYEVSKIY, R. M., Doctor of Technical Sciences, and BUYANOVSKIY, I. A., Candidate of Technical Sciences

[Abstract] The methodology of optimizing materials for frictional metal-oil-metal couples on the basis of laboratory test data is reviewed, and illustrated with a typical example of many different test procedures. Lubricating oils are customarily evaluated by temperature measurements in KT-2 or MAST-1 four-ball friction machines rotating at 1 rpm, various friction schemes being realizable depending on the contact configuration and the materials in contact. Among possible configurations here are: 1) four balls; 2) sphere on ring; 3) sphere on three flats; 4) sphere on three rollers; 5) cone on ring; 6) cone on three rollers. With a linear average relation between critical oil temperature and limiting seizure temperature established for calibration, these two and other test procedures yield the dependence of both volumetric and gravimetric wear on the critical temperature as well as the pressure dependence of surface wear for any lubricant in a given friction couple. The test data on a broad range of organic lubricating oils in pinion-gear and cylinder-piston couples have been found to fit closely along the best averaging straight line regardless of the method of measurement. They therefore can be used for optimum selection of lubricant for specific friction couples and operating modes. Figures 6; references 20: 16 Russian, 4 Western. [197-2415/12947]

UDC 621.891:621.822.5

JOURNAL BEARINGS FOR SUBMERSIBLE HIGH-SPEED ELECTRIC PUMPS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 20-21

MAKHOVENKO, A. I., Engineer, and ROSHIN, M. N., Engineer

[Abstract] A series of electric pump sets has been developed for reliable intermittent watering of pasture land and filling of ponds in arid regions. These "Rodnik-V" sets consist of a submersible vertical high-speed (up to 12,000 rpm) pump with a water-filled 0.8-3.5 kW electric motor on top and a gasoline engine with an electric transmission, all running on water-lubricated journal bearings. The bearings are made of the S-1-U metal-fluorocarbon composite material specially developed for this application, because Textolite loses its stability and graphite-resin loses its impact strength in water. In this material bronze powder with Teflon filler is firmly embedded a mechanically strong substrate and covered with a thin Teflon layer for smooth run-in. Local heating causes Teflon, which has a higher expansion coefficient

than bronze, to ooze out of the pores and to quench the hot spots. The thermal conductivity of this material is approximately the same as that of babbitts and its operating temperature range is -100 - $(+280)$ °C, with no corrosion in hot fresh water or in sea water. It is not only self-lubricating with a breakaway friction coefficient of 0.06-0.07 but also vibration resistant. Both upper and lower thrust bearings, as well as the pair of inside-out guide bearings, are mounted on the impeller shaft with stationary sleeves of 45Cr14Ni14V2Mo stainless steel (nitrided on the active side) in the bearing shields. The series consists of three models with the VEN 4-2-35 pump differently staged for three ranges of pressure head. All three have been extensively and successfully tested under nominal loads, without noticeable wear after 2500 h and then another 5000 h (6500 h corresponds to 4 years of service), except for some less than catastrophic wear of the axially and most heavily loaded lower thrust bearing. Figures 2.

[197-2415/12947]

UDC 621.662.2.001.24

METHOD OF DESIGNING FEED REGULATOR MECHANISMS FOR VANE PUMPS IN HYDRAULIC MACHINE DRIVES

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 17-21

ZAYCHENKO, I. Z., Doctor of Technical Sciences

[Abstract] The design of feed regulator mechanisms for vane pumps is outlined, beginning with calculation of the resultant vertical and horizontal components of force on the casing from the pressure distribution in the working fluid on both suction and delivery sides. The principal rotor parameters are eccentricity and number of vanes, or vane pitch in a uniformly periodic array. These parameters are determined from the dependence of both force components on them over a complete revolution-cycle and from the resulting performance characteristics at nominal speed, with rotors with odd numbers of vanes being considered here. A simple manual regulator, an adjustable screw which presses a spring against the casing, is then designed accordingly. A more efficient automatic regulator has two plungers which press on the casing from diametrically opposite sides, the one on top driven by a spring which is fluidically controlled by an adjustable screw through a valve and a throttle with a reservoir of regulating fluid necessarily included in this system. Formulas for design of the basic regulator components and for evaluation of their performance are presented along with typical numerical data on pumps with 3-15 uniformly spaced vanes. Figures 8; tables 2; references: 4 Russian.

[197-2415/12947]

CRITICAL SPEED OF RUNNER IN AIR SUCTION SET

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 30-33

PANFILOV, Ye. A., Candidate of Technical Sciences, and KORITYSSKAYA, L. Ya., Engineer

[Abstract] The critical speed of a runner in an air suction set is calculated by the integral method of successive approximations according to I. A. Birger. This method accounts for mass and stiffness distributions over various runner segments, without requiring consideration of some special features which characterize low-power pneumatic and electric machines. Calculations are shown for a single-shaft set with the d.c. electric drive motor mounted on two bearings and the air suction pump overhanging on the shaft extension at one end. The system of two corresponding equations of vibratory motion in the vertical plane are put in the form $y_1 = \omega^2 K_{y1} y_1$, $y_2 = \omega^2 K_{y2} y_2$ with the operators K_{y1} , K_{y2} expressed in terms of double integrals with respect to the horizontal coordinate. Moments of inertia and stiffness are calculated, assuming that masses are distributed over segments of a smooth cylindrical shaft. The algorithm for calculating the resonance frequency and thus the critical speed is constructed for any appropriate number of sections along the shaft and is readily programmable for a computer. Results of calculations made for an AVP-4 air suction set yield a critical speed of 5219 rps for the basic variant with all components, versus 4750-5570 rps obtained from oscillograms during experimental tests, and 3242-5259 rps depending on the degree of simplification by disregarding gyroscopic moments or motor components such as armature iron stack and commutator. Figures 3; tables 3; references: 6 Russian.

[197-2415/12947]

HIGH-VELOCITY IMPACT OF THIN-WALLED ELASTOPLASTIC STRUCTURES ON SURFACE OF COMPRESSIBLE FLUID

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 84 (manuscript received 9 Jul 82) pp 161-169

BAZHENOV, V. G., KOCHETKOV, A. V., KRYLOV, S. V. AND UGODCHIKOV, A. G., Gorkiy

[Abstract] High-velocity impact of a thin elastoplastic structure on the surface of a compressible fluid is analyzed for deformation of both. The problem is formulated mathematically in a cylindrical system of coordinates. The corresponding system of nonlinear equations simulating the interaction are solved for a structure generally consisting of plates and shells, for

an ideal fluid with nonsteady and nonhomogeneous boundary conditions at the free surface, and for the appropriate initial conditions. The algorithm of numerical solution by the method of variable steps involves a synthesis of two explicit schemes and, for motion of the fluid a straight-through count on a movable grid according to S. K. Godunov. A modular program package has been written for a BESM-6 high-speed computer and was tested on the model problem of a spherical shell of radius R_s coupled to a perfectly stiff body of mass M_b dropping into water. The results of calculations reveal flexure waves and then separation waves as the contact zone expands and then contracts, with a cavitation zone appearing in the fluid and elastoplastic strains building up in the structural material. The authors thank A. G. Gorshkov for discussion and valuable comments. Figures 6; references 17: 15 Russian, 2 Western.

[163-2415/12947]

UDC 539.3

DERIVATION OF EFFECTIVE WAVE OPERATOR FOR MOTION OF MEDIUM WITH ISOLATED INHOMOGENEITIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 84 (manuscript received 14 Mar 83) pp 67-76

KANAUL, S. K., Leningrad, and LEVIN, V. M., Petrozavodsk

[Abstract] Vibratory motion of a nonhomogeneous medium is analyzed by the method of effective fields in the long-wave approximation. The effective wave operator for averaging the integro-differential equation of motion is derived, first with scattering by a single generally anisotropic inclusion and then with scattering by a random array of ellipsoidal inclusions taken into account. As a variant of the problem is considered an isotropic composite material with spherical inclusions. The attenuation of elastic waves in such a medium is calculated, the expression for the attenuation coefficient becoming much shorter when the volume concentration of inclusions is sufficiently small to make their interaction negligible. References 17: 5 Russian, 12 Western (4 in Russian translation).

[163-2415/12947]

EFFECT OF END CONSTRAINTS OF CYLINDRICAL SHELL TRANSMITTING FLUID ON ITS DYNAMIC CHARACTERISTICS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84 (manuscript received 10 Feb 82) pp 88-98

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[Abstract] The problem of vibration and stability of cylindrical shells transmitting fluid is analyzed for two asymmetric combinations of end constraints, rigid clamping of one end and free other end or rigid clamping of one end and free support of other, taking into account the nonideality of any real clamping. A circular pipe of medium length $\sqrt{h/R} < L/R < \sqrt{R/h}$ is considered (L - length, R - inside radius, h - wall thickness) under both static pressure and dynamic pressure, the latter depending on the radial deflection of the pipe. The differential equations of motion for such a shell, based on the semizero-moment theory and put in dimensionless form, are solved for the appropriate sets of boundary conditions. The characteristic equation, a fourth-degree algebraic one, yields the vibration frequencies and the damping. A special theorem generalizes the solutions and simplifies the calculations for an incompressible fluid. Calculations have been made on an HP 21 MX computer, with the ratio c of acoustic velocity in the fluid to acoustic velocity in the pipe material serving as measure of compressibility. The lowest vibration frequency as a function of the fluid velocity in the presence of aerodynamic damping was calculated on this basis for an ideally incompressible fluid ($c = \infty$), water in steel pipe ($c = 0.3$), air in steel pipe ($c = 0.07$), air in duralumin pipe ($c = 0.0651$), CO_2 in aluminum pipe ($c = 0.05$), with not only the magnitude of the fluid velocity varied but also its direction reversed. Accordingly, not only flow from clamped end to free or freely supported end but also in the opposite direction was considered. For comparison were also considered symmetric combinations of constraints, namely rigid clamping or free supports at both ends. The results indicate that supporting or clamping the free outlet end of a pipe is advantageous from the standpoint of damping and stability. However, the theoretical conclusion that a cylindrical shell can become unstable at any arbitrarily low velocity of a fluid flowing from clamped end to freely supported end or from free end to clamped end does not agree with precise physical reality. Figures 6; references 13: 2 Russian, 2 Czechoslovak, 9 Western.

[51-2415/12947]

RESONANCES DURING NONLINEAR VIBRATIONS OF CYLINDRICAL SHELLS CONTAINING LIQUID

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84 (manuscript received 11 May 83) pp 99-104

BOYARSHINA, L. G., Institute of Mechanics, UkrSSR Academy of Sciences, Kiev

[Abstract] Nonlinear coupling between elastic vibrations of a cylindrical shell and oscillations of the free surface of a liquid not completely filling the shell is analyzed on the basis of Navier boundary conditions at both lower and upper ends of the shell. The elastic displacements (axial, radial, circumferential) of the shell are expanded into double trigonometric series each, while the equations of motion for an elastic shell carrying a liquid are given in generalized coordinates characterizing antisymmetric oscillation modes of the free liquid surface and any motion of the shell through space as well as any wave processes in it are disregarded. An analysis of these equations reveals that vibrations of the shell are always coupled to oscillations of the free liquid surface, the coupling being strongest at certain ratios of their respective fundamental natural frequencies ω_1, ω_2 (shell) and v_1, v_2 (liquid). An analysis of the solution reveals the possibility of not only internal resonance (liquid) and external resonance (shell) but also combined resonance, a typical example being "rotation" of the free liquid surface which produces flexural vibrations of the shell "traveling" around the circumference. The frequency ratios for resonance depend on whether the number of wave periods around the circumference is even or odd. In the case of an even number they are $\omega_1/v_1 = 1, 2, 3$. In the case of an odd number the ratio $\omega_1/v_1 = 2$ is most interesting. The conditions for dynamic instability of oscillations of the free liquid surface are established on the basis of stability analysis of all possible modes of coupling and the corresponding amplitude-frequency characteristics. Figures 1; references: 6 Russian.

[51-2415/12947]

CLASSIFICATION OF MOTIONS OF ZHUKOVSKIY GYROSTAT

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84
 (manuscript received 20 Dec 82) pp 104-111

VARKHALEV, Yu. P. and GORR, G. V., Institute of Applied Mathematics and Mechanics, UkrSSR Academy of Sciences, Donetsk

[Abstract] N. Ye. Zhukovskiy has described free motion of a gyrostat with one fixed point (Gostekhizdat, 1949) by the system of three Euler equations

$$\begin{aligned} \dot{Ap} &= (B - C)qr + m_2r - m_3q \\ \dot{Bq} &= (C - A)rp + m_3p - m_1r \\ \dot{Cr} &= (A - B)pq + m_1q - m_2p \end{aligned}$$

for a hollow solid filled liquid. This system of equations admits two integrals: $Ap^2 + Bq^2 + Cr^2 = h^2$ and $(Ap + m_1)^2 + (Bq + m_2)^2 + (Cr + m_3)^2 = x_0^2$, where p, q, r are components of the angular velocity vector, m_1, m_2, m_3 are components of the hydrostatic moment, A, B, C are the principal moments of inertia with respect to the fulcrum point, and h^2, x_0^2 are integration constants. An analysis of the solution by the P. V. Kharlamov method of hodographs (Novosibirsk University, 1965) leads to four possible classes of motion, each under certain conditions: 1) α -conditionally-periodic motions in the general case; 2) isoconical motions with the invariant relation $p(x_0 c_1 - m_1) + q(c_2 x_0 - m_2) + r(c_3 x_0 - m_3) = h^2$; 3) precessions, regular and semiregular including degeneracy into uniform rotation; 4) asymptotically uniform motions. The authors thank P. V. Kharlamov for interest. References 11: 7 Russian, 4 Western (1 in Russian translation).

[51-2415/12947]

DYNAMICS OF ELASTIC CYLINDER CONTAINING FLUID UNDER SHORT-CYCLE LOAD

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84
 (manuscript received 27 Jun 83) pp 83-88

NIKITIN, S. K., Institute of Mechanics, UkrSSR Academy of Sciences, Kiev

[Abstract] The effect of a liquid filling an elastic cylinder with rigid bottom on the stress and strain dynamics of such a cylinder under an annularly distributed pulse load is analyzed on the basis of a mathematical model which, in addition to the equations of motion for an elastic shell of revolution, includes the Navier-Stokes equations and the equations of

continuity for an incompressible fluid. The boundary conditions are impermeability of the elastic wall and free sliding along its surface. After transformation from a Cartesian system of coordinates X,Y,Z in the physical space to curvilinear systems of coordinates x^1, x^2, x^3 for the solid and y^1, y^2, y^3 for the liquid in the mathematical space, into which the regions of integration are mapped as squares, the differential equations are discretized into an explicit scheme of finite differences with the step on the time axis shorter than the time of travel of a perturbation wave through a step in space. The problem is solved by the method of invariant immersion. It has been solved numerically for a steel cylinder with either uniform or linearly upward tapering wall thickness and with water to three different levels: full height, 3/4 height, 1/2 height. Figures 5; references 6: 5 Russian, 1 Western (in Russian translation).

[51-2415/12947]

UDC 539.3

STABILITY OF REINFORCED CYLINDRICAL SHELLS UNDER COMBINED TORSION, AXIAL TENSION AND INTERNAL PRESSURE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 5, May 84
(manuscript received 7 Mar 83) pp 54-59

PALCHEVSKIY, A. S. and PRYADKO, A. A., Institute of Mechanics, UkrSSR Academy of Sciences, Kiev

[Abstract] The linear problem of elastic stability under combined torsion, axial tension, and internal pressure is solved by the Timoshenko method of energy increment and work for cylindrical shells with discrete arrays of reinforcing hoops and stringers, the latter hinge-supported at both ends. The deflection is defined as a sine function of two coordinates in a way which eliminates any inconsistency of radial stability loss with zero deflection at nodes between stringers. Six cases are considered specifically, namely stringers twisted and bent, only bent, or only twisted with hoops twisted and bent or only twisted. New expressions are obtained for the critical shearing stresses, also for stability loss with the number of circumferential wavelengths equal to a multiple of the number of stringers. The results of some numerical calculations are compared with data on curved webs under combined shear and normal stresses. Figures 2; tables 1; references 5: 4 Russian, 1 Western.

[124-2415/12947]

UDC 539.374

NONLINEAR PROBLEMS FOR COMPOUND SHELLS OF REVOLUTION

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 5, May 84
(manuscript received 29 Mar 83) pp 40-47

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[Abstract] Fundamental nonlinear problems for arbitrary axisymmetric shells of revolution with either uniform or variable thickness, made of either compressible or incompressible material, are formulated on the basis of the general nonzero-moment theory with Kirchhoff-Love hypotheses and the plasticity theory of strain under active load. The corresponding system of two resolvent differential equations with variable coefficients for the two displacement components is derived from geometrically and physically nonlinear relations in the theory of thin shells. These equations are solved first for elementary shells generated by rotation of second-degree curves as well as for circular toroidal, conical, and cylindrical shells. The problem is then extended to compound shells, specifically coupled spherical-toroidal, cylindrical-toroidal, and spherical-cylindrical pairs. It is further extended to shells with reinforcement in the form of a thin circular ring. The nonlinear state stress has been analyzed and numerically evaluated for three shell structures under uniform internal pressure, each with a hold of the same radius and reinforced around the contour: 1) sphere-torus-ring; 2) sphere-torus-cylinder-ring; 3) sphere-ring. Figures 2; tables 1; references 21: 18 Russian, 3 Western. [124-2415/12947]

UDC 539.6.013.42

INTERNAL TRANSIENT-STATE WAVE PROBLEM FOR MULTILAYER SPHERE IN ACOUSTIC MEDIUM

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 5, May 84 (manuscript received 17 Mar 83) pp 32-40

BABAYEV, A. E., Institute of Mechanics, UkrSSR Academy of Sciences, Kiev

[Abstract] The internal transient-state wave problem is formulated for multi-layer spherical shell in an acoustic compressible medium. The shell is assumed to consist of symmetrically alternating thin (carrier) layers and thick (filler) layers and to contain a point source of pressure pulses at the center. The corresponding equations of the linear theory of elasticity are based on Kirchhoff-Love hypotheses. The system of equations, second-order differential equations of motion, shell dynamics, and wave propagation, are solved simultaneously by the method of Laplace integral transformation with respect to time. The procedure has been applied, for illustration, to a triple-layer shell consisting of two concentric alumoborosilicate glass

shells separated by an epoxy-maleine resin filler. The results indicate that the transient response of such a shell to a balanced square pressure pulse depends largely on the interaction of reflecting surfaces. Figures 4;

references: 16 Russian.

[124-2415/12947]

TESTING AND MATERIALS

UDC 629.124.74:622.242

CHARACTERISTICS OF FLOATING DRILL RIGS FOR NORTHERN SEAS

Leningrad SUDOSTROYENIYE in Russian No 12, Dec 84 pp 3-4

GUDZE, A. A. and IGNATOVICH, V. S.

[Abstract] Floating drill rigs for use in Northern seas must be designed to operate under a variety of hydrometeorological conditions, to withstand strong winds and waves, to withstand low temperatures combined with maximum wind and wave intensity in winter, and to provide a comfortable environment for the crew. Rig dimensions and equipment layout determine the structural and performance characteristics. Stability and safety are the main considerations in the selection of rig materials. Steel, in particular, must have high tensile and shear strength as well as sufficient low-temperature impact strength, good weldability, and high long-term corrosion resistance in sea water. High-strength steels are avoided, because they are not as weldable and machinable as some other grades, in addition to losing plasticity and becoming prone to brittle fracture at low temperatures. Steel grades D32 and Ye32 listed in the USSR Register, with a yield strength of 300 MPa, are adequate for this application under normal conditions. Alloy steels with a yield strength of 400 MPa or even 120-150 mm thick steel plate with a yield strength of 600 MPa are used only where stresses are extremely high, namely for the support racks. References: 3 Russian.

[179-2415/12947]

UDC 621.793:669.295

QUALITY OF STEEL SURFACE AFTER TITANIDING WITH LIQUID PHASE

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 58-59

ANDRYUSHECHKIN, V. I., Doctor of Technical Sciences, and DASHKOVA, I. F., Candidate of Technical Sciences

[Abstract] Thermochemical treatment of steel with the liquid phase offers the advantages of high process speed and controllability of structure as well as of chemical and phase composition. Titaniding of steel by this

method was studied in experiments for establishing the dependence of the surface finish on process parameters. Paste of titanium hydride with an organic binder was deposited on specimens of St 20, St 45, and U8 steels in layers of various thicknesses up to 300 μm . These specimens were then vertically suspended in a furnace and heated to 1380-1450 K (10-80 K above melting point on contact) in an inert atmosphere, whereupon they were soaked isothermally for 15 min. The dimensions of specimens were measured with a micrometer before and after coating. The surface roughness was measured with a Mitutoyo profilograph before and after heat treatment. The results indicate that the surface microroughness depends principally on the temperature of heat treatment, more precisely on the superheat above the eutectic point, and indirectly on the thickness of the original paste layer. Nonuniform spreading of the liquid, which causes beading and thus a rougher surface, begins at a lower superheat when the original paste layer was thicker. Generally raising the superheat, even for a thin layer, will reduce the resulting surface roughness. Both parameters must be carefully controlled for optimization of the titaniding process. Figures 3; references: 2 Russian.

[197-2415/12947]

UDC 620.178.16

DEPENDENCE OF ABRASIVE-IMPACT WEAR OF VARIOUS STRUCTURAL STEELS ON IMPACT VELOCITY

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 30-34

MATVEYEVSKIY, B. R., Candidate of Technical Sciences

[Abstract] An experimental study of six martensitic steels (U8A, 40KhNMA, 5KhV2S, D7KhFNSh, 45KhN2MFASh, 40Kh13) and two austenitic steels (40Kh13G12, 110G13L) was made in a special test stand at the Moscow Institute of Petrochemical and Natural Gas Industry imeni I. M. Gubkin, for the purpose of evaluating their wear resistance under conditions of abrasive impact. Two of the steels, D7KhFNSh and 45KhN2MFASh (pearlite) chisel steels, have been developed by the Institute's Department of Metals Science. Specimens of the martensitic steels were oil-quenched from 800-950°C and then tempered at 180-200°C. Specimens of the austenitic steels were water-quenched from 1100°C without subsequent temper. The impact velocity of abrasive particles was varied over the 1-7 m/s range and separate tests were run for each velocity level. The width of x-ray diffraction lines and the depthwise microhardness profile in steel, also the grain size distribution (maximum grain size 630 μm) in the particle beam, were determined before and after each test. The results indicate that, following abrasive impact action, the microhardness in all steels is maximum at approximately 0.05 mm depth below the surface and the layer above becomes prone to brittle fracture. Both microhardness and specific wear, also the width of x-ray diffraction lines, peak under an impact velocity within the 5-7 m/s range, dropping steeply below and only slightly above that range. Austenitic steels wear

less than the others within this range, while martensitic steels wear less under impact at velocities not exceeding 1 m/s. These data provide a basis for selecting a structural steel to match specific characteristics of the abrasive medium. The x-ray diffraction measurements were performed by Candidate of Technical Sciences V. M. Sinayskiy and Candidate of Technical Sciences L. P. Grigorenko at the Institute of Metals Science imeni A. A. Blagonravov, USSR Academy of Sciences. Figures 3; tables 4; references: 12 Russian.
[197-2415/12947]

UDC 620.178.6

LENGTHENING LIFE EXPECTANCY OF FRICTION COUPLES BY THERMOMECHANICAL FORMING FOR OPERATION IN FLUIDS WITH ABRASIVE INCLUSIONS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 84 pp 34-37

KERSHENBAUM, V. Ya., Candidate of Technical Sciences

[Abstract] A method of thermomechanical forming has been developed for lengthening the life expectancy of friction couples in fluids with abrasive inclusions. The method combines a thermal effect with a mechanical effect, namely melting the granulate cake of cladding material and its flawless structurization during crystallization under external mechanical pressure of the tool. Friction or electric current, depending on the method of cladding, serves as source of heat released for melting. The most preferable cladding materials have been found to be heterogeneous hard alloys of the Ni-Cr-B-Si-C group, wear-resistant at temperatures up to 600°C and corrosion-resistant in many aggressive media, owing to their polyphase structure with high concentrations of carbides and borides as well as carboborides dissolved in nickel. Three of these alloys, SNGN-60 and VSNGN-35,50, were tested in an experimental study for determination of their suitability as material for face seals and their comparison with 9Kh18 steel. Identical specimens simulating conventional pump seals were clad with these materials, some by thermomechanical forming and others by conventional gas-flame or plasma-beam beading. They were subsequently tested under conditions equivalent to pumping abrasive fluids, with SiC powder of the 5 μ m size fraction used as abrasive. Tests were performed with "rotating ring against stationary ring" configuration. A sample size of 10 specimens for each test and four measurements on each specimen yielded data sufficiently reliable for concluding that thermomechanical treatment produces harder (HRA 81-86) and more wear-resistant cladding than gas-flame or plasma-beam treatment (HRA 77-81). All three Ni-Cr-B-Si-C alloys were found to have much better characteristics than 9Kh18 steel, a cladding of the best of them (VSNGN-50) having an 18.5 times lower wear rate when thermomechanically formed. Figures 2; tables 2; references 17: 15 Russian, 2 Western (1 in Russian translation).

[197-2415/12947]

STUDIES ON COMPATIBILITY OF MATERIALS IN FRICTION

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 84 pp 13-16

BUSHE, N. A., Doctor of Technical Sciences

[Abstract] Several aluminum alloys with structurally soft tin and lead have been evaluated and compared with plain tin-base babbitts and bronzes as soft bearing materials. With the Sommerfeld relation and Hersey-Stribeck curves for the friction coefficient as reference, the load capacity of bearings has been evaluated theoretically and experimentally as a function of the run-in time, the run-in pressure, and the temperature. A relation has been established between the increment of load capacity and the work of friction forces, with the ratio of maximum load capacity after run-in to total friction work during run-in as the performance criterion for comparative evaluation of materials. Squeeze-out and parting of the soft components into a separate film, a measure of wear, have been tracked by metallographic-structural examination of surface layers. The results, in addition to the results of fatigue and corrosion tests in electric motors (D49, TD330, D70), indicate that aluminum alloys with up to 15% Pb and 1-10% Sn have even better anti-frictional characteristics than plain tin-base alloys such as the A050-1 (50% Sn) with $C = 13.28 \text{ kPa/J}$. Figures 5; tables 1; references 17: 16 Russian, 1 Western.

[197-2415/12947]

TRENDS IN AND OUTLOOK FOR DEVELOPMENT OF FLEXIBLE PRODUCTION SYSTEMS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 3-7

VASILYEV, V. N., Candidate of Technical Sciences

[Abstract] As new technologies appear and expand, the trend in automatic production in the machine building industry is toward flexible systems, with rigid system remaining limited to the more stable technologies. There are now about 200 flexible production systems installed in the world, 60 in the Soviet Union and other socialist countries, 30 in the United States, 50 in Japan, and the rest in Western Europe. Introduction of such systems makes it feasible to reduce the labor force by 70%, the resetting time by 85%, the tooling cost by 50%, and the overall manufacturing cost by 20%. These average figures are based on typical experience by the Citroen Cie. in France and comparative studies made by American experts. Introduction of flexible production systems, including automatic fabrication and assembly, appears to be most cost effective when it involves machine tools with numeric control and universal standard cutters. Accessories are the most neglected components of a flexible production system and need the most attention; next follows

automation of stockroom and transport. Design of blanks and products must be adapted to automatic production, just as flexibility of production must match the diversity of blank and product configurations. There are hardly any limitations on algorithms and programs conceivable for automatic production control. As to the personnel running an "unmanned" production system, high skill and broad professional background are required. Establishment of new enterprises and factories with flexible production should be accompanied by conversion of existing ones, which can be done in five stages: ubiquitous introduction of group technology; changeover of all machine tools with numerical control to direct numerical control by a host computer; automation of stockroom and transport; addition of a third shift with "unmanned" production under minimum supervision; addition of devices and methods or replacement of old ones to raise the levels of automation and flexibility. Implementation of this procedure according to a reasonable schedule should yield an operative automatic machine building plant within 10-15 years.
[197-2415/12947]

UDC 621.822.5:678.5

NONMETALLIC JOURNAL BEARINGS FOR TROLLEYS OPERATING WITH VULCANIZATION VATS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 p 37

SHIROKOVA, Z. P., Candidate of Technical Sciences, PERSHINA, N. I., Engineer
KOLESNIKOVA, R. P., Engineer, and CHOP, Yu. K., Engineer

[Abstract] A self-lubricating nonmetallic material, AG-1500-S05 carbon-graphite, has been developed by the "Soyuzuglerod" Industrial Association of All-Union Carbon Products Manufacture as replacement of OtsS 5-5-5 bronze for journal bearings in trolleys in the Tambov rubber vulcanization plant. Blank cylinders of this material 57-170 mm in diameter and 150-250 mm long were turned and cut into specimens 10 mm in diameter and 20 mm long, for wear testing in an MDP-1 machine with disks under a pressure of 1.18 MPa and at a peripheral velocity of 0.15 m/s. The wear after 18 h rubbing against a steel disk was 5 μm , at a rate of 0.4 $\mu\text{m}/\text{km}$. The material was found to be adequate for use in an atmosphere containing SO_2 , CO_2 , and hydrocarbons near a vulcanization vat operating with saturated vapor under a pressure of $4+0.2$ atm at $143+3^\circ\text{C}$, in process cycles of 7-15 min vapor admission \rightarrow $30+0.2$ min vulcanization time \rightarrow 7-15 min vapor discharge. Sleeves of this material have already been installed on three trolleys, by hot shrinking at 300°C , but they still need to be tested for friction with a surface roughness $R_a = 2.5 \mu\text{m}$ against a steel shaft with surface roughness $R_a = 0.63 \mu\text{m}$ maximum before being finally approved. References: 1 Russian.
[197-2415/12947]

UDC 658.512.011.56

COMPUTER-AIDED EQUIPMENT LAYOUT FOR TECHNOLOGICAL COMPLEXES

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 46-48

SOLOMENTSEV, Yu. M., Doctor of Technical Sciences, PROKHOROV, A. F., Doctor of Technical Sciences, and KALININ, V. V., Engineer

[Abstract] A comprehensive production flow chart for a new machine building complex is shown which should serve as basis for computer-aided design of such a complex. It is universal insofar as it can be applied to mass production, batch production, or custom production, with individual, grouped, or broad-mix machining in conventional or flexible production. It covers the entire product development cycle, from initial product prototype through pilot production to final product and spare parts. It also correspondingly provides for different production programs depending on the size of the product mix. Four zones are defined here, with some overlap, namely: I) very low flexibility (1-3 products) and high volume (from 50,000 pieces up); II) low flexibility (2-8 products, 5,000-75,000 pieces); III) medium flexibility (4-24 products, 2,000-10,000 pieces); IV) high flexibility (from 18 products up, up to 5,000 pieces). The production cycle proceeds from zone IV to zone I, as the final product is selected from many prototype versions and the number of pieces produced increases correspondingly from a few to many.

Figures 3.

[197-2415/12947]

UDC 658.512.011.56

METHODOLOGY OF COMPUTER-AIDED DESIGN OF AUTOMATIC PRODUCTION LINES FOR MECHANICAL FORMING OF MACHINE FRAME COMPONENTS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 49-50

PROKHOROV, A. F., Doctor of Technical Sciences, MITROFANOV, V. G., Doctor of Technical Sciences, KORYACHEV, A. N., Candidate of Technical Sciences, and KALININ, V. V., Engineer

[Abstract] A methodology of computer-aided design of automatic production lines has been developed jointly by the Moscow Institute of Machine Tools and Tools and the Moscow Special Design Office for Automatic Production Lines and Systems, specifically for lines of machine tools mechanically forming machine frame components. Its essential feature is detachment, in real time, of production line design from product engineering design and manufacturing process design. Its overall objective is to implement the engineering concept of an automatic production line with satisfactory technical and economic performance indicators. The algorithm of computer-aided design subdivides the problem into five segments: 1) preparation and input of data; 2) analysis of technical constraints on the automatic production line;

3) automation of the manufacturing process; 4) layout of the automatic production line; 5) evaluation of technical and economic performance characteristics. The sequence is followed by adjustment to customer's specifications. The first segment is most laborious and so far least computerized. The design process has, therefore, been linearized and thus accelerated by carrying each segment, especially the first, to an optimum final solution without iterations from subsequent segments. The mathematical models covering all design levels are those which describe the elementary technology and structure of the manufacturing process, simulate the automatic production, and describe the layout of spindle turrets, then the layout of the line. The manufacturing process is structured for single-tool machining, multitool machining with lumped spindle clusters, and multitool machining with distributed spindle turrets.

[197-2415/12947]

UDC 658.512.011.56

ENCODING OF ENGINEERING AND MANUFACTURING PARAMETERS OF MACHINE FRAME ELEMENTS IN COMPUTER-AIDED DESIGN SYSTEM FOR TECHNOLOGICAL COMPLEXES

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 51-54

VETKO, A. N., Engineer, KALININ, V. V., Engineer, KHRUSTALEVA, Engineer, KORYACHEV, A. N., Candidate of Technical Sciences, and PROKHOROV, A. F., Doctor of Technical Sciences

[Abstract] The existing code GOST 14.417-81 for computer-aided design is reviewed and adapted so as to completely define all machine frame elements in terms of shapes and sizes relevant to engineering and manufacturing procedure. All surfaces subject to machining have been found to be tentatively classifiable into four groups: A) plane; B) internal cylindrical or conical; C) external cylindrical or conical; D) others (spherical, toroidal, etc). Most machinable surfaces fall into group B (80%), followed by group A (10%). The code is therefore designed preferentially for flats and holes, which together comprise 90% of all items. It is designed for locating a part first in a main (basal) system of coordinates and then an auxiliary one, in projection or isometrically. The code covers rough and fine machining operations required as well as all dimensions with tolerances necessary for mating parts of an assembly. Figures 4; tables 3; references: 4 Russian.

[197-2415/12947]

UDC 658.512.011.56

METHODOLOGY OF PRESENTATION AND STORAGE OF INFORMATION ON TECHNOLOGY OF PARTS FABRICATION IN COMPUTER-AIDED DESIGN SYSTEM

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 54-57

KALININ, V. V., Engineer, VETKO, A. N., Engineer, and PROKHOROV, A. F., Doctor of Technical Sciences

[Abstract] A methodology has been proposed and introduced jointly by the Moscow Special Design Office for Automatic Production Lines and Systems and the Moscow Institute of Machine Tools and Tools for presentation and storage of parts engineering and manufacturing data in a computer-aided design system. It covers three modes of classification and standardization: 1) machining of elementary surfaces; 2) machining of compound surfaces; 3) machining of blanks. It is designed specifically for machine frame elements, where holes play a dominant role in subsequent assembly. It includes sequencing of operations in accordance with applicable route charts and dimensioning with tolerances for each successive operation. It is designed for using the computer memory most efficiently and the computer time most economically.

Figures 3.

[197-2415/12947]

UDC 658.512.011.56

COMPUTER-AIDED DESIGN OF ROUTING TECHNOLOGY FOR MECHANICAL FORMING OF PARTS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 57-59

KALININ, V. V., Engineer, VETKO, Engineer, and PROKHOROV, A. F., Doctor of Technical Sciences

[Abstract] A technology of routing the operations in a parts forming process is outlined which can be designed by computer and optimized with respect to manufacturing economy and precision tradeoff. The problem becomes more difficult when a novel combination of elementary surfaces is encountered. A new matrix must then be constructed in the data base and stored in the memory, whereupon the optimum routing will be selected according to the basic algorithm of economy and precision tradeoff. This methodology of computer-aided design is adaptable for implementation on any machine, from YeS computer to microcomputer. Figures 1.

[197-2415/12947]

METHOD OF OPTIMIZING STRUCTURE OF PARTS MANUFACTURING PROCESS IN COMPLEX OF AUTOMATIC PRODUCTION LINES

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 59-62

PROKHOROV, A. F., Doctor of Technical Sciences, KALININ, V. V., Engineer, and SULTAN-ZADE, N. M., Candidate of Technical Sciences

[Abstract] The problem of optimizing the structure of a technological process such as machining of parts in an automatic production line is formulated as one of maximizing the productivity. The target function and the constraints are defined in terms of respective mathematical expectations, for a set of single-side machining tools, the corresponding set of part transfers being sought which will yield that optimum. The algorithm begins with optimization of the number of tool groups, a group being defined as a set of tools referable to one common system of coordinates with their relative positions in space not changing during the technological process. The transfers of a part are then maximally concentrated within one such group, which inevitably leads to maximization of the cost per tool, whereupon a controlled deconcentration follows for attainment of the maximum average productivity in the limiting subset of transfers after the original set has been subdivided into two, then three subsets and so on till the optimality criterion reaches its maximum. Figures 2.

[197-2415/12947]

INDUSTRIAL ROBOTS AND ROBOTIC SYSTEMS SERVING PRODUCTION

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 84 pp 74-77

FOMINA, L. V., Engineer

[Abstract] An industry-wide exhibit of industrial robots and robotic systems is shown in the "Machine Manufacture" pavilion at the Exhibition of Achievements in the National Economy USSR. This exhibit includes the AKKB 8⁰44.1 automatic production line with a KM 0.63 Ts4212 automatic manipulator for forge-press and punch operations, the MPUS-10 multipurpose automatic manipulator, the TKhP 78 shelf-type automatic manipulator for segregated stocking of diverse parts including very long ones, and the MRU-901/901A/902 series of three loading-unloading automatic manipulators with 0.08/0.08/0.35 kg capacity. These automatic manipulators have pneumatic drives with fluidic control logic. The exhibitors who have developed and built them are respectively the Design Engineering and Technological Institute of Forge-Press Robots, the Simferopol Design Engineering and Technological Institute, the Special Design Office for Chemical Machinery, the All-Union Scientific Research Institute of Hydraulic Drives and the Simferopol Scientific-Industrial Association "Pnevmatika". Among accessories of special interest are the hydraulic drives SP2, SP3 as well as the UE85 hydraulic distributor and the UPSI-4 pulse-feed lubricator--all developed, built, and tested at the Leningrad Experimental Plant for Hydraulic Automation. Tables 1.

[197-2415/12947]

FLEXIBLE AUTOMATION OF INSTRUMENT CHECKING

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 84 pp 28-29

BRZHEZINSKIY, V. M., TSEYTLIN, Ya. M., DEMCHENKO, V. Ya. and GRECHUKHINA, G. V.

[Abstract] Automatic test stands are being developed for checking wide-range transducers and gauges of class 3-5 precision, specifically those used in thickness inspection of thin coatings. These test stands are built according to the principle of flexible automation with a control computer. Programs are stored on magnetic tape for maximum flexibility of algorithms and other software, with peripheral devices controlled and data exchange effected by signals with 8-digit bytes. As to the measuring equipment, the carriage is driven automatically from an "Elektronika DZ-23" computer with velocity feedback. In the UVPL-200 test stand for measuring linear displacements within the 0-200 mm range the instrument transducer under inspection produces a signal proportional to the displacement of its pin and measurable with either a digital voltmeter or a frequency meter. The test stand is checked against a hairline reference gauge, under a photoelectric microscope, with deviations from certified norm fed to the control computer for automatic correction. The test stand will be enhanced by using an "Elektronika TZ-16" minicomputer and adding an adaptation system for checking gauges used in measurement of ultrathin 2-100 nm thick coatings. The equipment here consists of a high-sensitivity highly interference-immune modulation interferometer and two piezoceramic plates carrying reference mirrors in series, the second one for stabilizing the position of the interference pattern against forced vibrations of only finitely stiff interferometer components, then a photo-receiver whose signals actuate a null indicator. The latter starts the minicomputer program with appropriate action on the commutator switch of a set of interface plates. The piezoceramic plates are calibrated on the basis of transition from one interference fringe to the next, at a given wavelength of the light source. The digital integrator in the feedback system does not have a null drift, which analog integrators have, but the readout frequency must still be at least twice the frequency of the highest-order significant harmonic of forced interferometer vibrations. Data input at a frequency of 12 Hz is adequate for low-frequency processes, for higher-frequency processes it is necessary to install pneumatic dampers. References: 4 Russian.

[118-2415/12947]

MEASURING DIAMETERS OF CYLINDRICAL SURFACES WITH SHAPE IMPERFECTIONS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 84 pp 29-30

MARKOV, N. N. and VAYKHANSKIY, S. M.

[Abstract] Readings of the diameter of a cylindrical surface taken by the two-point method in various cross sections vary, because of shape imperfections of a manufactured part. This is taken into account in the special interpretation of the maximum pass-through diameter as that of a right cylinder making contact with the tips of the farthest protruding surface asperities. Estimation of the diameter on this basis conforms to Taylor's principle and to the physics of a kinematic coupling with a cylindrical member. The problem of determining the diameter of such a contiguous cylinder from radius readings along its surface, measured from an arbitrary reference axis inside, is solved by an iterative algorithm of shifting the reference axis so as to equalize its distances to all those farthest protruding points. It is necessary to find the coordinates of five such points on the cylindrical surface which are most and equally distant from that axis, in the cylindrical system of coordinates, with four of the corresponding coefficients negative and one coefficient equal to unity. These can be obtained by resting the cylinder on four points of its surface which form a rectangle and then placing on the surface two instrument transducers on diametrically opposite sides. Both transducers feed signals through a commutator switch to a Fourier analyzer of difference functions which extracts all odd harmonics and scales them down appropriately for synthesis of the radius component as function of the diameter, and also to a synthesizer of the diameter component where diameter readings are divided by two and Fourier expansion is not necessary for extraction of the even harmonics. The two components are then added, yielding the sought radii. This method has been automated with an "Elektronika 60" computer for measurements with a "Talirond 2" circulometer around the circumference and with a "Talilin 4" profilograph longitudinally. It is very accurate, with the rms random error not exceeding $0.04 \mu\text{m}$ for $0.5\text{-}2 \mu\text{m}$ amplitudes of diameter fluctuation and the systematic error not exceeding $0.15 \mu\text{m}$ for the $0\text{-}80 \mu\text{m}$ range of dimensional deviations from the gauge setting. Figures 1; references: 3 Russian.

[118-2415/12947]

UDC 621.9.02.08:536.6.08

MEASUREMENT OF CUTTING TEMPERATURE WITH PHOTODIODES DURING TURNING OF HARD ALLOYS WITH DIAMOND CUTTER

Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 84 pp 21-22

SHIN, I. G.

[Abstract] A method of contactless temperature measurement has been developed for determination of the cutting temperature of hard alloys machined on lathe with a synthetic diamond bit. It involves recording with a special photoreceiver the infrared radiation which both the part and the tool emit while in contact. A high-sensitivity germanium diode FD-3 serves as photoreceiver, its resistance changing upon absorption of electromagnetic waves associated with the infrared radiation and this change of resistance generating an electric transducer signal. An important part of the procedure is calibration of the photodiode against a standard thermocouple. An alloy chip produced under given cutting conditions is placed on the top surface of the cutter bit and a drop of silver holding the hot junction of a Chromel-Copel thermocouple is pressed against the bit by set screw through a nichrome plate, the latter being heated electrically as part of the secondary circuit of an autotransformer across the 220 V power line. Simple relations based on the electric circuit and the Stefan-Boltzmann equation yield the necessary temperatures for calibration. According to experimental data, the optimum cutting temperature for carbonado bits lies within the 320-380°C range. Dimensional analysis of data on machining of the hard alloys VK-15 and VK-20 has yielded semiempirical relations for their cutting temperature $\theta_{15} = 638v^{0.45}s^{0.4}t^{0.43}$ and $\theta_{20} = 317v^{0.59}s^{0.36}t^{0.49}$ respectively (cutting rate $v = 20-70$ m/min, feed rate $s = 0.02-0.08$ mm/rev, cutting depth $t = 0.1-0.5$ mm). Figures 2; references: 2 Russian.

[118-2415/12947]

UDC 621.391

TESTING OF STATIONARY OBJECTS FOR MONITORING THEIR TRANSFER FUNCTIONS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 4 Nov 83) pp 22-26

MIRONOVSKIY, L. A., Leningrad Institute of Aircraft Instrument Design

[Abstract] A tester of dimensionality m (overall order of the system of differential equations describing it) for monitoring the transfer function of objects consisting of n linear stationary components is synthesized, the problem being to extract the class of components which will respond to input test signals by producing measurable output signals. The condition necessary and sufficient for a linear stationary tester of such an object to exist is that no tested component of the object have a transfer function of an order

higher than the tester dimensionality m . This condition is formalized in a theorem, with a corollary which generalizes the existence of a tester taking into account the coupling between components of the object. For analyzing the performance of such a tester, it is assumed that defects in the object alter its transfer functions. Resulting error multiplication in the response signals is avoided by forming a linear combination of test signals which would add up to zero in the absence of defects and thus makes each component signal depend on the defects in one object component only. This method of defect location can be further refined with the aid of Lissajoux figures, revealing not only the number of defective components but also the type of defect-- provided that not more than one coefficient in each transfer function has been distorted. A tester with a dimensionality much lower than that of the object can be used for monitoring under dynamic conditions as well. Article was recommended by the Computer Department. Figures 2; references: 1 Russian.

[127-2415/12947]

UDC 62-52

INNOR METHOD OF STABILITY ANALYSIS OF PERIODIC PROCESSES IN DIGITAL AUTOMATIC CONTROL SYSTEMS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 27, No 10, Oct 84 (manuscript received 18 Nov 83) pp 14-17

KOLESNIKOV, N. K., Rostov-na-Donu

[Abstract] The stability of periodic processes in digital automatic control systems with linear pulsing component is analyzed by the method of z -polynomials. The analysis requires transforming the approximate equation of a natural periodic process in a harmonically linearized system $1 + S^*(\alpha, \phi, N)W(z, \epsilon) = 0$ (S^* linearization factor, W transfer function of the referred linear pulsing component) into a canonic polynomial equation of n -th degree in z . In accordance with the Schur-Kohn criterion for the roots of the latter, the matrix of its coefficients is tested for innor-positiveness as necessary and sufficient condition for stability. The algorithm of this analysis has been programmed in PL/1 language for a digital computer. It is illustrated on a linear pulsing component of a digital automatic control system with the

transfer function $W(z) = \frac{3.087z^2 - 1.141z - 0.556}{2.008z^3 - 4z^2 + 1.992z}$. Figures 1; references 5:

4 Russian, 1 Western (in Russian translation).
[127-2415/12947]

UDC 531.787.1

CHARACTERISTICS OF TUBULAR SPRINGS WITH VARIOUS CROSS-SECTIONAL SHAPES

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 27, No 12, Dec 84 (manuscript received 18 Jan 84) pp 35-37

PIROGOV, S. P., Tyumen Industrial Institute imeni Lenin Komsomol

[Abstract] The basic characteristics of tubular springs with various cross sections are investigated by formulas derived in other studies, mostly by the author. The investigations showed that electrical springs are 1.2 - 2.3 times more sensitive than flat oval springs. The sensitivity of thin-walled thermometric springs is almost an order of magnitude smaller than that of manometer springs; as the wall thickness increases, the sensitivity of springs with different cross sections equalizes. The use of relative rigidity as the comparison criterion for selecting springs with the optimal shape and cross sectional dimensions is explained. This criterion, which is the ratio of the square of the displacement of the spring caused by maximum pressure to its deflection caused by unit force applied to the end of the spring in the direction opposite the working displacement. This criterion makes it possible to take into account all three of the factors that characterize spring properties: sensitivity, flexural strength and stress. The selection of tubular springs for use in thermometers is described. References:

5 Russian.

[140-6900/12947]

UDC 539.3:534.1

BEHAVIOR OF CYLINDRICAL SHELL WITH PAYLOAD MASS AT ONE END UNDER AXIAL IMPACT ON OTHER END

Moscow IZVESTIYA AKADEMII NAUK SSSR: MAKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 84 (manuscript received 11 May 83) pp 186-190

BRIGADIROV, G. V. and TOLOKONNIKOV, L. A., Tula

[Abstract] An experimental study of cylindrical shells under axial impact against a rigid barrier underneath was made for a design and performance evaluation, these shells carrying a load mass attached to the upper other end. The special test stand allowed varying the vertical downward velocity of a shell. It was also adaptable to various shell sizes and shapes, various shell materials, and various magnitudes of the load mass. The theoretical premise for this study were differential equations of the hyperbolic kind describing the dynamic state of a shell. The impact conditions for tests were stipulated in terms of the dimensionless velocity $V\sqrt{\rho(1-\nu^2)}$ (ρ - density,

ν - Poisson ratio, E - Young modulus) and the latter was varied from $4 \cdot 10^{-3}$ to $15 \cdot 10^{-3}$. The selection of shells for testing was based on geometrical

similarity, namely thickness-to-radius and length-to-radius ratios. The load was selected on the basis of mass relative to mass of deformable part of a shell. Shells made of AlMg6 aluminum alloy and of D16T aluminum alloy were tested, taking into consideration strain hardening and the elastic limit of these materials. The kinematics of shell motion and the dynamics of shell deformation, namely buckling and residual deflection, as well as displacements of the load mass were recorded by high-speed photography. Photographs were decoded by a special procedure under a universal instrument microscope. The data were then processed by the method of graphical differentiation. The results of the study indicate that thin shells and short shells will buckle with folds triangular in the plan view at the impact end. As the impact velocity is increased, the number of these folds increases and an annular fold will form at the load end. With decreasing length of shells, the triangular folds are replaced first by elliptical ones and then by annular ones while eventually no fold will form at the load end even at an impact velocity as high as 60 m/s. With increasing thickness of shells, an annular fold will form at the load end already at an impact velocity lower than 25 m/s, but the deflections at both ends will decrease. Figures 9; references 8: 6 Russian, 2 Western.

[163-2415/12947]

UDC 624.014.02

STRESSED-STRAINED STATE OF THICK CYLINDRICAL AND SPHERICAL SHELLS WITH DILATATION

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84
(manuscript received 14 Sep 82) pp 33-37

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[Abstract] Thick cylindrical and spherical shells made of elastic dilatant materials obeying the law $\epsilon_y = (1 - 2\nu) \frac{I_1}{E} + k_d \sqrt{I_2}$ are considered (ϵ_y - volume strain, E - Young's modulus, ν - Poisson's ratio, k_d - dilatation coefficient, I_1, I_2 - first and second stress invariants). Assuming a negligible weight of the shells and an isotropic dilatation coefficient, the general mathematically nonlinear problem for arbitrary radial and circumferential stresses σ_r, σ_θ can be split into two independent and mutually exclusive linear ones. In the first problem the internal load is heavier than the external one and $\frac{1}{2}(\sigma_\theta - \sigma_r) > 0$. In the second problem the external load is heavier than the internal one and $\frac{1}{2}(\sigma_r - \sigma_\theta) > 0$. The first problem is solved for an infinitely long cylindrical shell and for a spherical one, after the corresponding equation of equilibrium in each case has been formulated in displacements. In the case of an infinitely long cylindrical shell the longitudinal strain is $\epsilon_z = 0$ and the elastic longitudinal stress is $\sigma_z^e = \nu(\sigma_r^e + \sigma_\theta^e)$. In the case of a spherical shell $\epsilon_z = \epsilon_\theta$ and $\sigma_z = \sigma_\theta$. The second problem is solved analogously. References 2: 1 Russian, 1 Western.

[51-2415/12947]

AXISYMMETRIC THERMOELASTOPLASTIC STRESSED-STRAINED STATE OF BRANCHING SHELLS DURING SIMPLE LOADING

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84
 (manuscript received 21 Nov 83) pp 46-50

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[Abstract] A branching shell of revolution is considered, namely a compound shell consisting of a principal one with open branches at nodal points (points where the median meridian of respective two shells intersect). Each branch constitutes a chain of several shells of revolution with arbitrary meridional sections and with temperature-dependent mechanical properties. The aggregate shell is initially in a natural unstressed state at the ambient temperature, whereupon it is heated nonuniformly and also loaded mechanically by forces acting symmetrically with respect to the axis of the principal shell. The problem of stresses and strains is formulated in a cylindrical system of coordinates with the origin on the axis of the principal shell, the median meridian of each branch being described parametrically over the corresponding space intervals. The problem is solved on the basis of Kirchhoff-Love hypotheses in quasi-static and geometrically linear formulation, assuming simple or almost simple deformation of each branch. The solution includes relations describing transition through nodal points. As an example is considered a cylindrical shell with periodically spaced reinforcing annuli, such a shell being heated convectively by the ambient medium and loaded by a linearly increasing internal pressure. The problem has been solved numerically by the method of grids, for a load $p = 0.4t$ MPa and an ambient temperature

$\theta_{ai} = (600 - 580e^{-2t})^\circ\text{C}$ at the inside surface of the cylinder but $\theta_{ao} = (220 - 200e^{-0.5t})^\circ\text{C}$ at the outside surfaces of the cylinder and the annuli (t - time in seconds). Figures 4; references: 6 Russian.

[51-2415/12947]

EFFECT OF REINFORCEMENT ON MAGNITUDE OF CRITICAL LOAD FOR INVARIANT-WEIGHT CYLINDRICAL SHELLS WITH HOLES

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84 (manuscript received 19 May 83) pp 50-54

KOVALCHUK, N. V., Institute of Mechanics, UkrSSR Academy of Sciences, Kiev

[Abstract] The stability of invariant-weight cylindrical shells with large rectangular holes in their lateral surface and with discrete reinforcement is analyzed by the method of finite elements. A finite element here is a smooth shell panel between holes reinforced around its contour by hoop and

stringer segments, the latter having identical or different cross sections and some of them in some cases missing. The stiffness matrix for each element is derived on the assumption of continuous contact between shell and reinforcement members relative to all three linear and two angular displacement components. Stability analysis reduces to preliminary determination of the subcritical stressed-strained state and subsequent construction of a homogeneous system of equations describing the balance between additional forces at nodal points, followed by calculation of the critical-load parameter λ_{cr} values at which this system of equations will have a nontrivial solution. The smallest value of this parameter yields the magnitude of the critical load. For illustration, the algorithm is applied to cylindrical shells with large rectangular holes on hinge supports at both ends and under uniformly distributed axial compression forces acting on the sheath. Both shell and reinforcement are assumed to be made of the same material, the stiffness of hoops and stringers being proportional to their cross section area. Numerical results have been obtained for the cyclically symmetric part of such a shell with appropriate boundary conditions on both vertical and horizontal axes of symmetry. The critical load was calculated according to the relation $P_c = 2 \pi R t E \lambda_{cr}$ (R - radius of shell, t - thickness of shell, E - Young's modulus of shell material). Figures 1; tables 2; references: 2 Russian.

[51-2415/12947]

UDC 624.045

INFLUENCE OF MOMENTS IN SUBCRITICAL STATE ON OPTIMAL DESIGN PARAMETERS OF MULTILAYER CYLINDRICAL SHELLS FOR NONUNIFORM RANDOM LOAD

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84
(manuscript received 4 Mar 83) pp 55-60

POCHTMAN, Yu. M. and GORBATOV, A. S., Dnepropetrovsk Institute of Structural Engineering

[Abstract] Optimization of the design of multilayer cylindrical shells for carrying nonuniform random loads is considered from the standpoint of a subcritical state not free of moments and with inclusion of transverse shear. A specific case is a hinge-supported shell under an axisymmetric external pressure distributed sinusoidally over the length and as a homogeneous ergodic random function of the angular coordinate around the circumference. The shell is assumed to consist of several transversely isotropic layers of not necessarily equal thicknesses, each layer having both symmetric and asymmetric (with respect to its median surface) geometrical and physico-mechanical properties. Minimum weight is selected as the optimality criterion, with the vector of variable parameters including ratios of layer thicknesses and material properties (density and modulus of elasticity). The range of acceptable solutions is defined by physical constraints on stability, strength, reliability, and geometrical dimensions (thickness). Strength is characterized by the ultimate stress in the weakest layer. Stability is characterized by the critical load, its upper bound corresponding to a zero-moment initial

state and absence of transverse shear. Reliability is referred to a homogeneous narrow-band Gaussian load field stationary with respect to both angular coordinate and time. The problem of design optimization has been formulated as one of nonlinear programming, for solution on a YeS-1050 with a modified "double re-entry" algorithm of random search. A numerical experiment was performed for triple-layer shells, with both sheaths made of AV-T1 aluminum alloy and PKhV-1 perchlorovinyl as filler material. Calculations of the minimum weight for a given reliability level over a given length of service indicate that initial moments and transverse shear as well as longitudinal fluctuation of the load field each increase the minimum weight of short shells, the influence of each factor weakening and the weight economy improving as the length of shells increases. The authors thank V. L. Krasovskiy for discussion of the results. Figures 4; references: 9 Russian. [51-2415/12947]

UDC 539.401

CALCULATION OF STRESSED-STRAINED STATE OF PLATES AND SHELLS BY METHOD OF COMPUTER-SIMULATED COMPLEX LOADING

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84
(manuscript received 3 Sep 82) pp 68-73

VASIN, R. A. and STOLYAROV, N. N., Institute of Mechanics, Moscow State University

[Abstract] The method of computer-simulated complex loading is applied to the design of plates or shells with elastoplastic material for carrying a uniform load. The procedure for calculating stresses and strains by this method begins with formulation of the governing relations in tensor form and involves subsequent simulation of complex loading in computer experiments according to special programs, programs based on preliminary computer calculations. Such a numerical experiment is demonstrated on the use of stress and strain deviators for establishing the relation between stress and strain vectors on the basis of postulated isotropy. Both the theory of deformation and the theory of flow with isotropic hardening are involved here. The corresponding nonlinear problem, after quasi-linearization, is solved by the method of self-corrective increments using the intensity of the transverse load as the equilibrium tracking parameter. Numerical results obtained for hinge-supported and rigidly clamped square plates illustrate the effectiveness of this method. Figures 2; references 13: 12 Russian, 1 Western.

[51-2415/12947]

STRESSED STATE OF ANISOTROPIC NONHOMOGENEOUS CYLINDERS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 8, Aug 84
(manuscript received 28 Jun 83) pp 11-18

VASILENKO, A. T. and PANKRATOVA, N. D., Institute of Mechanics, UkrSSR Academy of Sciences, Kiev

[Abstract] The problem of axisymmetric deformation is solved for an anisotropic hollow cylinder arbitrarily nonhomogeneous across its thickness and with various boundary conditions at its ends. The elasticity field of the material is assumed to be symmetric with respect to one plane. The conditions of contact between adjacent heterogeneous layers are formulated for the corresponding equations of equilibrium and Cauchy equations, in a cylindrical system of coordinates r, z, θ and in accordance with the appropriate theory of elasticity. The general algorithm is applied specifically to a multilayer cylinder under axial and tangential stresses at the ends, their distributions being unknown but equivalent to a known axial force and a known twisting moment respectively. The boundary conditions at the ends are zero axial and angular displacements. Calculation of stresses at some distance from the ends is facilitated by application of St. Venant's principle. As a typical example is considered a double-layer shell, each layer made of an orthotropic material with their principal axes of elasticity rotated in opposite directions symmetrically with respect to the corresponding coordinate axes x, θ . Figures 5; references: 10 Russian.

[51-2415/12947]

USE OF PNEUMATIC SUPPORTS IN VIBRATION TEST STANDS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 5, May 84
(manuscript received 23 Feb 83) pp 116-119

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[Abstract] Pneumatic supports, also acting as excitors, are used in vibration stands for testing large and heavy beam or shell structures with offset components. Such a support-exciter consists essentially of a pressure chamber and a pressure distributor. The distributor mechanism, whether cam or slotted disk or fluid jet, can be driven by a motor with speed regulation or by a sound generator with frequency regulation. The basic variant of a pneumatic support-exciter was tested in a special experimental rig and its performance was evaluated, of particular interest being the depth of pressure modulation and its frequency characteristic over a continuous spectrum. Vibrations of the object were measured and recorded by the optical method,

using a point source of light and a spherical mirror with the tape drive. Pressure oscillations in the chamber were measured with a manometer or a pressure transducer in the loop. Pressure oscillograms were recorded covering the entire range from zero pressure through the filling process to maximum pressure in the chamber, with modulation of the pressure at the top of this range. The results indicate that decreasing the size of the chamber would improve its frequency characteristics but also lower its stiffness and weaken the damping effect. The design of the pneumatic support-exciter was modified, accordingly, to remedy this conflict. Two chambers instead of one, a large low-pressure chamber for support and a small high-pressure chamber for excitation, separate the two functions with the possibility of optimizing each without penalty. Use of doubly-connected two pneumatic supports, one at each end, furthermore facilitates excitation of axial vibrations and eliminates the need for protective tension bars. Figures 4; tables 1; references: 4 Russian.

[124-2415/12947]

UDC 539.3:534.1

ENERGY DISSIPATION DURING VIBRATIONS OF THIN CIRCULAR PIEZOCERAMIC PLATES

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 5, May 84
(manuscript received 26 Apr 83) pp 77-82

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[Abstract] Energy dissipation in freely radially vibrating piezoceramic disks and rings with thickness-wise polarization is analyzed and evaluated, for the purpose of reconciling available theoretical and experimental data on the stressed state and the admittance of piezoelectric devices. Into consideration are taken not only piezoelectric but also dielectric and mechanical losses, all together amounting to only 0.01-0.2% of the power input and shifting the resonance frequencies downward correspondingly little. Calculations on an M-4030 computer reveal quantitatively that in the vicinity of fundamental resonance as well as in the vicinity of higher-order, second and third, resonances the six coefficients of admittance terms are monotonic functions of frequency, the minima and maxima of some corresponding to zero-crossovers of others. These coefficients depend also monotonically on the Poisson ratio. Calculations for a thin disk of TsTS-19 piezoceramic material indicate that both mechanical and dielectric loss tangents are comparable in magnitude with the piezoelectric one. All three are definable analogously and measurable, directly or indirectly and with the same inaccuracies, as in the case of longitudinal vibrations. Figures 1; tables 1; references 11: 6 Russian, 5 Western.

[124-2415/12947]

LOAD CAPACITY AND OPTIMAL DESIGN OF ELASTOPLASTIC CYLINDRICAL SHELLS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 20, No 5, May 84
(manuscript received 25 Jun 82) pp 47-53

DEKHTYAR, A. S., RASSKAZOV, A. O. and RUBLEV, V. S., Kiev Highway Institute

[Abstract] A closed elastoplastic multilayer circular cylindrical shell hinge-supported at both ends is to be optimally designed for a given load capacity under a transverse load uniformly distributed over the perimeter. Allowing plastic shear in the layers and at the contact boundaries between layers upon reaching the yield point, the maximum permissible load intensity is determined without constraints on the optimizable number and thicknesses of layers nor on their arrangement in the stack. Typical calculations are shown for seven-layer shells with four carriers and three filler layers alternating in the stack. The design problem is solved theoretically for semiinfinite cylindrical shells under a radial load at the free end and practically for short cylindrical shells, with an $L/R = 1.6$ length-to-radius ratio, under a transverse load at the center, all shells being weakest in shear and a single-layer shell constituting in each case the limiting reference case. The algorithm of optimal design has been programmed in FORTRAN for a BESM-6 high-speed computer. Results of calculations indicate that laminating a single-layer shell can typically increase the strength by 50% with only a 20% increase of weight. Figures 3; references: 3 Russian.
[124-2415/12947]

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